Alaska Fisheries Technical Report Number 44

RUN TIMING AND ABUNDANCE OF ADULT SALMON IN THE KWETHLUK RIVER, YUKON DELTA NATIONAL WILDLIFE REFUGE, ALASKA, 1992

March 1998

Region 7

U.S. Fish and Wildlife Service • Department of the Interior

Alaska Fisheries Technical Report Number 44
March 1998

Run Timing and Abundance of Adult Salmon in the Kwethluk River, Yukon Delta National Wildlife Refuge, Alaska, 1992

Ken C. Harper

Key Words: weir, Onchorynchus keta, O. tshawytscha
O. nerka, O. gorbuscha, O. kisutch
sex ratios, gill net marks, carcases,
stream-life

U.S. Fish and Wildlife Service
Kenai Fishery Resource Office
P.O. Box 1670
Kenai, Alaska 99611

Table of Contents

List of Tables

List of Figures

List of Appendices

Run Timing and Abundance of Adult Salmon in the Kwethluk River, Yukon Delta National Wildlife Refuge, Alaska, 1992

KEN C. HARPER

U S Fish and Wildlife Service, Kenai Fishery Resource Office
P.O. Box 1670, Kenai, Alaska 99611, (907) 262-9863

Abstract.—A resistance board weir was used to collect detailed run timing, abundance, and biological data from salmon on the Kwethluk River between June 20 and September 12, 1992. A seasonal total of 30,596 chum *Oncorhynchus keta*, 9,675 chinook *O tshawytscha*, 1,316 sockeye *O nerka*, 45,952 pink *O gorbuscha*, and 45,605 coho *O. kisutch* salmon were counted through the weir. Peak weekly passage occurred July 5-11 for chinook, July 12-18 for chum, July 26-August 1 for sockeye, August 9-15 for pink, and August 23-29 for coho

Sex composition in the chum salmon escapement shifted from predominately males to females as the run progressed and females composed 57% of the run. The proportion of females varied by week for chinook, coho and sockeye salmon Females represented 24 8% of the chinook, 43.5% of the coho, and 53 5% of the sockeye salmon escapement.

Dominant age groups for salmon were 0 3 for chum, 1.4 and 1.2 for female and male chinook, 1 3 for sockeye, and 2 1 for coho salmon Gill net marks were detected on 10% of the chinook, 5% of the chum, <1% of the pink, 6% of the sockeye and 3% of the coho salmon, passing through the weir

A total of 8,208 chum, 1,169 chinook, 122 sockeye, 14,674 pink, and 42 coho salmon carcasses or spawned out salmon were passed downstream over the weir Stream-life for salmon above the weir was estimated as follows· chum 10 days, chinook 27 days, sockeye 38 days, and pink 10 days.

Other species counted through the weir were 1,976 Dolly Varden *Salvelinus malma*, 1,652 whitefish *Coregonus* spp , 344 Arctic grayling *Thymallus arcticus*, nine northern pike *Esox lucius*, and 15 rainbow trout *O mykiss* Whitefish moved primarily in September while other resident species moved primarily in July. Only larger sized resident species (>340 mm) are represented due to the effect of picket spacing

Water flows were measured during the season at 10 and 81 m^3/s. The weir was submerged in September when flows were estimated to be above 81 m^3/S.

Introduction

The Kwethluk River, a lower Kuskokwim River tributary located on the Yukon Delta National Wildlife Refuge (Refuge) provides important spawning and rearing habitat for chum *Oncorhynchus keta*, chinook *O. tshawytscha*, pink *O. gorbuscha*, sockeye *O. nerka*, and coho salmon *O. kisutch* (Figure 1)(Alt 1977; U.S. Fish and Wildlife Service 1992). Adult salmon returning to the Kwethluk River migrate 159 river kilometers (rkms) through the lower Kuskokwim River before reaching the Kwethluk River and then migrate upstream as many as 160 rkms to reach spawning grounds. In the lower Kuskokwim River, salmon pass through and are harvested in a commercial fishing district and one of Alaska's most intense subsistence fisheries (Francisco et al. 1995; U.S. Fish and Wildlife Service 1988).

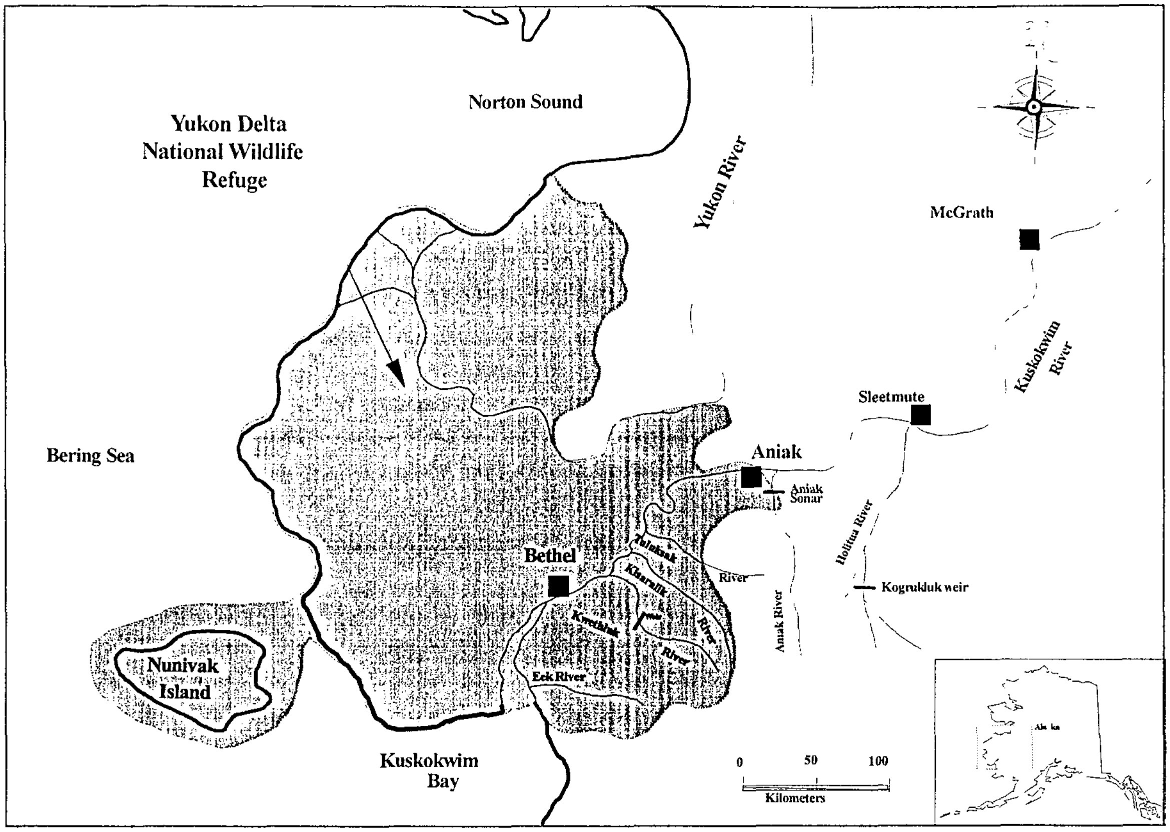


Figure 1.-Lower Kuskokwim River tributaries on the Yukon Delta National Wildlife Refuge, Alaska, 1992.

Subsistence fishing also occurs in the Kwethluk River main stem. Spawning populations of salmon in the Kwethluk and other rivers provide food for brown bears *Ursus arctos* and other carnivores, raptors, and scavengers In addition, resident fish and salmon fry rely heavily on the nutrient base provided by salmon carcasses (U S Fish and Wildlife Service 1992)

The Alaska National Interest Lands Conservation Act (ANILCA) mandates that, within the Refuge, salmon populations and their habitats be conserved in their natural diversity ANILCA mandates may not be met, because reliable escapement data on lower Kuskokwim River tributary fish stocks are missing The Alaska Department of Fish and Game's (Department) management objective for chum, chinook, sockeye, and coho salmon in the Kuskokwim River is "to achieve desired escapement objectives and allow for the orderly harvest of fish surplus to spawning requirements" (Francisco et al. 1995) Escapement goals have not been established for sockeye and pink salmon which are not actively managed in the Kuskokwim River Commercial and subsistence catches of these species are considered incidental by the Department.

Spawning escapement declines of Kuskokwim River chinook salmon during the early 1980's prompted the Department to change from a harvest-guideline-based salmon management strategy to an escapement-objective-based strategy in 1983 Chinook salmon spawning escapements continued to decline and commercial fishery restrictions were initiated in 1985 These restrictions eliminated the directed commercial harvest for chinook salmon and imposed a maximum stretch mesh size of $\leq$ 15 2 cm for gill nets. Prior to the restrictions, gill nets were unrestricted in mesh size, and larger mesh sizes including those larger than 20 3 cm were selective toward female chinook salmon Commercial harvests prior to the mesh size restrictions averaged 42 8% female chinook salmon, while post restriction harvests averaged 29 0% female chinook salmon (Francisco et al. 1995) As a result of this management action, the percentage of gill net marked females has increased at the Department's escapement monitoring project on the Kogrukluk River. The increase in gill net marks indicated females were escaping from nets and reaching the spawning grounds (Francisco et al 1995). Gill net marks also serve as an indicator of fishing intensity on the monitored stocks.

The Department presently determines commercial openings by evaluating salmon abundance indexes and monitoring selected escapements Abundance indexes include drift gill net test fisheries and the use of commercial fishery catch statistics These test fisheries are located in the lower and middle stretches of the Kuskokwim River. Escapement monitoring occurs at two fish-counting sonars and a weir (Francisco et al. 1995) One sonar is located in the lower Kuskokwim main stem near Bethel, and the other is in the Aniak River, a major tributary to the middle Kuskokwim River The weir is located in the Kogrukluk River, a major tributary to the upper Kuskokwim River.

Using an escapement-objective-based management strategy is complicated by the presence of mixed stocks in the lower Kuskokwim River. Department managers try to avoid over-harvesting species and stocks returning to each of 11 major and numerous minor tributaries to the Kuskokwim River by distributing catch over time and area. Distribution of the catch over time is important, because each stock may have characteristic migratory timing (Mundy 1982) However, stocks or species returning in low numbers, or during the early or late portion of the runs, may be incidentally over-harvested during extended harvesting of abundant stocks Protection of smaller stocks, such as those returning to the Kwethluk River, requires run timing and escapement information

Aerial surveys have been used to monitor escapements to the Eek, Kwethluk, Kisaralik, Kasigluk, and Tuluksak Rivers, all lower Kuskokwim River tributaries on the Refuge. These surveys sporadically carried out between 1960 and 1994 generally occur when salmon abundance peaks on the spawning grounds (Schneiderhan 1983, 1988; Francisco et al 1995) Recognizing a need for a higher level of monitoring for lower Kuskokwim River tributaries, the Department operated a fish-counting sonar in the Kwethluk River during 1978 (Schneiderhan 1979) The sonar project was operated only one year due to inaccurate counts caused by organic debris in the water.

Aerial index estimates have been used to estimate relative abundances of salmon in the Kwethluk River since 1960. An aerial index objective of 7,000 chum salmon and 1,200 chinook salmon has been established using historical data (Francisco et al. 1995). Kwethluk River aerial index surveys conducted between 1960 and the present, have ranged from less than 1,000 to more than 19,600 chum salmon and from less than 100 to more than 2,000 chinook salmon (Appendix 1) Only two aerial index surveys for coho salmon were flown between 1960 and 1992

Aerial index estimates are infrequently used for current-year management because they are. (1) conducted when most salmon are on the spawning grounds, and after most of the commercial fishery occurs, (2) highly variable due to run timing inconsistencies, water and climatic conditions, and surveyor experience; (3) generally underestimate actual abundance, and (4) limited to an 'index area' which may represent only a fraction of the total spawning area Additionally, aerial index surveys do not provide age, sex, and size composition data used to detect escapement quality and brood year production

Salmon escapement monitoring projects in lower Kuskokwim River tributaries on the Refuge are ranked as priorities in the Refuge Fishery Management and Ecosystem Action plans by the U S Fish and Wildlife Service (Service) and the Department (U.S. Fish and Wildlife Service 1992) In 1991, a multiple year study was initiated by the Service to. (1) estimate daily salmon escapements in the Kwethluk River, (2) quantify the salmon age, sex and length composition; (3) estimate migration time from the test or commercial fishery to the weir; (4) monitor gill-net marks on salmon; (5) estimate optimal timing to gather aerial index survey data; and, (6) count other species passing through the weir.

High waters prevented the installation of the weir in 1991. Due to concerns raised by residents of Kwethluk over the effects of the weir, it was operated only during 1992 and was moved to a high priority project on the Andreafsky River, a lower Yukon River tributary in 1994

Study Area

The Kwethluk River is in the lower Kuskokwim River drainage (Figures 1 & 2). The region has a subarctic climate characterized by extreme temperatures. Temperatures range from summer highs near 15°C to average winter lows near -12°C (Alt 1977). Average yearly precipitation is approximately 50 cm with the majority falling between June and October. The rivers generally become ice free in the slow-moving sections by early May and freeze-up occurs in late November.

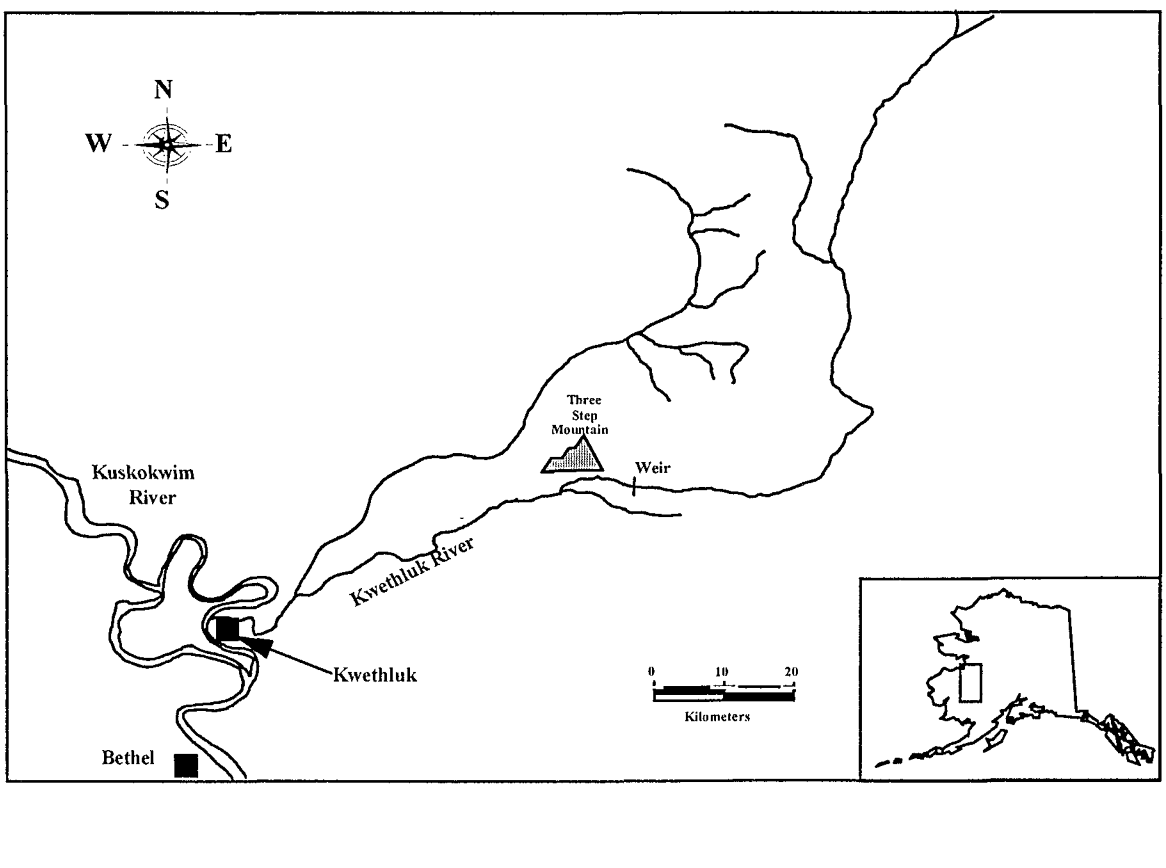


Figure 2.-Location of Kwethluk River weir, 1992.

The Kwethluk River originates in the Eek and Crooked mountains, flows northwest approximately 222 km, and drains an area of about 3,367 km^2. Braiding and gravel substrates are found in the middle section of the river where the weir was placed Below the middle section, the lower 47 km consists of a deeper, muddy-bottomed channel averaging 53 m in width (Alt 1977). Turbid water conditions also characterize this lower river section during the summer, the result of active stream cutting on tundra banks

Methods

Weir Operation

A resistance board weir (Tobin 1994) with picket spacing of 3.5 cm spanning a 51-meter section of river was installed at rkm 80 (N 60°, 29', 160°, 05' W). The weir was installed in an area with active braiding, and riparian vegetation that consisted of willow and alders. River substrate consisted of coarse gravel intermixed with sand and other fines Installation occurred in May 1992 before the high flows in late May and June. The weir was operational from June 20 to September 12, 1992 A staff gauge was installed on the shore side of the bulkhead and daily water levels were recorded at 0800 h each day Stream discharge was estimated using the method described by Hamilton and Bergersen (1984) with a Marsh-McBirney (Model 201-D) flow meter and top-setting wading rod. Water temperatures were recorded daily during the middle of the day

All fish were identified to species, counted, and noted for gill-net marks as they passed through the weir The trap was usually opened at 0700 h and closed at 1200 h or earlier depending on hours of daylight Cleaning and checking the weir for holes was performed daily before 0900 h Snorkeling was used to check weir integrity and substrate conditions Cleaning consisted of walking across each panel to submerge it partially and letting the current wash the debris downstream. Algal growths were removed by scrubbing with long-handled brooms Spent salmon and carcasses (carcasses) washing up on the weir were identified to species, counted and passed downstream at four hour intervals during routine cleaning operations

Biological Data

Sample weeks started Sunday and ended the following Saturday. A weekly quota of 160 chum, 140 chinook and 110 coho salmon were sampled at the beginning of each week Samples were collected in as short a period (1-3 d) as possible to approximate a pulse or snapshot sample (Geiger et al 1990) All fish within the trap were sampled to prevent bias A quota of 40 pink salmon was set for the season. Once weekly quotas were obtained, the trap was opened and fish were passed until the next sampling period.

Fish sampling consisted of measuring lengths, weights, and determining sex, collecting scales, and then releasing the fish upstream of the weir Each fish was also examined for gill net marks Length was measured to the nearest 5 mm from mid-eye to fork-of-caudal-fin for salmon, and nearest 1 mm fork length for other species Weights were collected to the nearest 100 g. Sex was determined by observing external characteristics. Scales were removed from the preferred area for age determination (Koo 1962, Mosher 1968) One scale was taken from each chum, sockeye, and pink salmon, and four scales were taken from each chinook and coho salmon A scale smear was collected from sampled rainbow trout and several scales were collected from whitefish and Arctic grayling. Scale impressions were made on cellulose acetate cards using a heated scale press and examined with a microfiche reader Salmon ages were then interpreted by a Department biologist and verified through comparison to commercial catch samples Ages for salmon were reported according to the European Method (Koo 1962) where numerals preceding the decimal denote freshwater annuli, and numerals following the decimal refer to marine annuli. Total years of life at maturity is determined by adding one year to the sum of the two digits on either side of the decimal of the European designation. Therefore, age 1.4 and 2.3 fish are both 6-year-old fish from the same brood year (1 4=1+4+1=6 and 2.3=2+3+1=6). This number is then subtracted from the year of capture to determine brood year.

A stratified random sampling design (Cochran 1997) was used to estimate age and sex specific escapements Age and sex specific escapements in a stratum, A_{hij}, and their variances, $V[A_{hij}]$, were estimated as:

$$\hat{A}_{hij} = N_h \, \hat{p}_{hij} \qquad \textbf{(1)}$$

and

$$\hat{V}\,[\hat{A}_{hij}] = N_h^2 \left(1 - \frac{n_h}{N_h}\right)\left(\frac{\hat{p}_{hij}(1-\hat{p}_{hij})}{n_h - 1}\right) \qquad \textbf{(2)}$$

where.

- N_h = total escapement of a given species during stratum h;
- $\hat{p}_{hij}$ = estimated proportion of age i and sex j fish, of a given species, in the sample in stratum h, and,
- n_h = total number of fish, of a given species, in the sample for stratum h.

Weekly samples were pooled into a single stratum when sample sizes were low. Estimates of escapement, and their variances, were summed across strata to obtain estimates for the season.

Because length, L, and weight-at-age changed during the season, and numbers of fish passing the weir varied by sampling stratum, weighted means were calculated for the season. Weighted mean lengths (and weights) by stratum, age, and sex were calculated as

$$\hat{\hat{L}}_{ij} = \frac{\Sigma\, \hat{L}_{hij}\ \hat{A}_{hij}}{\hat{A}_{ij}}\ , \qquad \textbf{(3)}$$

where $\hat{L}_{hij}$ = mean length of age i and sex j fish during week h.

Chi-square contingency table analysis was used to test for differences in age composition between the sexes. Because the standard test only applies to data collected under simple random sampling, adjustments were made to the test statistic following Rao and Thomas (1989) to account for the effect of a stratified sampling design on results. The χ^2 statistic, hereafter referred to as $\chi^2(\hat{\delta}.)$, was divided by the mean generalized design effect, $\hat{\delta}.$, as a first-order correction to the standard test (Rao and Thomas 1989). Estimated design effects for the cells and marginals are presented in the results.

Stream-life

The time each salmon species remains alive above the weir before washing downstream (stream-life) was estimated. Stream-life is important in determining the optimal timing for aerial surveys and was assumed to be the difference between the median cumulative passage dates of upstream migration and the median downstream passage of carcasses.

Results

Weir Operation

The weir was operational starting at 1700 hours on June 20, 1992. Prior to this time fish could pass the weir or trap and not be enumerated. A section of stream bed under the weir washed out during high water in early June and was repaired when waters receded. The trap and chute were in deep water (>70 cm) throughout the operation.

The weir passed large amounts of debris during May including pieces of tundra measuring 1 X 3 m and large pieces of ice measuring 45 m^2 (Tobin 1994) In September when relative water levels reached 1 m, and the water flow exceeded 81 m^3/s, six panels were pushed down to the waters surface. This occurred when downward pressure on the weir panels caused by excessive head upstream of the weir overpowered the lift created by the resistance boards When water levels reached 1 1 m, excessive head upstream submerged 12-14 panels, 5-15 cm below the surface.

Water turbidity was affected by an exposed permafrost bank that melted and dripped glacial till into the river above the weir Because water clarity was marginal down to the Kuskokwim River confluence, no chum or chinook salmon were observed spawning in the river below the weir

Water temperatures exceeded 10° C between July 2 and August 25, 1992 (Appendix 2). Discharge was measured on May 12 at 10 m^3/s and again June 12 at 81 02 m^3/s

Biological Data

A total of 30,596 chum, 9,675 chinook, 1,316 sockeye, 45,952 pink, and 45,605 coho salmon passed through the weir between June 20 and September 12, 1992 (Figure 3, Appendix 3) Salmon carcasses passing downstream over the weir consisted of 8,208 chum, 1,169 chinook, 122 sockeye, 14,674 pink and 42 coho salmon (Appendix 5). Other species counted through the weir included 1,976 Dolly Varden *Salvelinus malma*, 1,652 whitefish *Coregonus pidschian* and *Prosopium cylindracium*, 9 northern pike *Esox lucius*, 15 rainbow trout *O mykiss,* and 344 Arctic grayling *Thymallus arcticus* (Figure 4, Appendix 3) Fork lengths of sampled resident fish were generally greater than 340 mm (Appendix 6)

Chum salmon —Chum salmon was the first salmon species counted and passed through the weir on June 21 Peak passage (*N*=5,821) occurred the week of July 12-18 (Figure 3; Appendix 7) The median cumulative passage date at the weir was July 18 (Appendix 4)

Four age classes were identified from 1,267 scale samples and weights were collected from 1,219 chum salmon passing the weir Ages identified were 0 2, 0 3, 0.4 and 0 5, and present in both males and females (Table 1). Females composed an estimated 57 4% of the escapement (Appendix 7) Sex composition shifted from predominately males before the week of July 5-11 to predominately females after that (Figure 5) The escapement was composed primarily of age 0.3 (61 1%) and age 0.4 (34.6%) fish. Age 0.4 chum salmon were most abundant until the week of July 12-18, when the escapement age composition shifted primarily to age 0 3 fish. Females and males in age class 0 3 composed 37% and 24%, respectively, of the weir escapement. Females and males in age class 0.4 each composed 17% of the escapement past the weir (Appendix 7). Age composition differed between sexes ($X^2(\hat{\delta}) = 8\ 09$, df = 3, $P < 0.004$).

Chum salmon males in the escapement averaged (weighted mean) 561 mm and 3,366 g and females averaged 519 mm and 2,406 g. Female mean length at age (weighted) was smaller than males (Table 1).

Gill-net marks were observed on 5% (*N*=1,458) of the chum salmon passing the weir (Appendix 3) Carcasses were first observed on

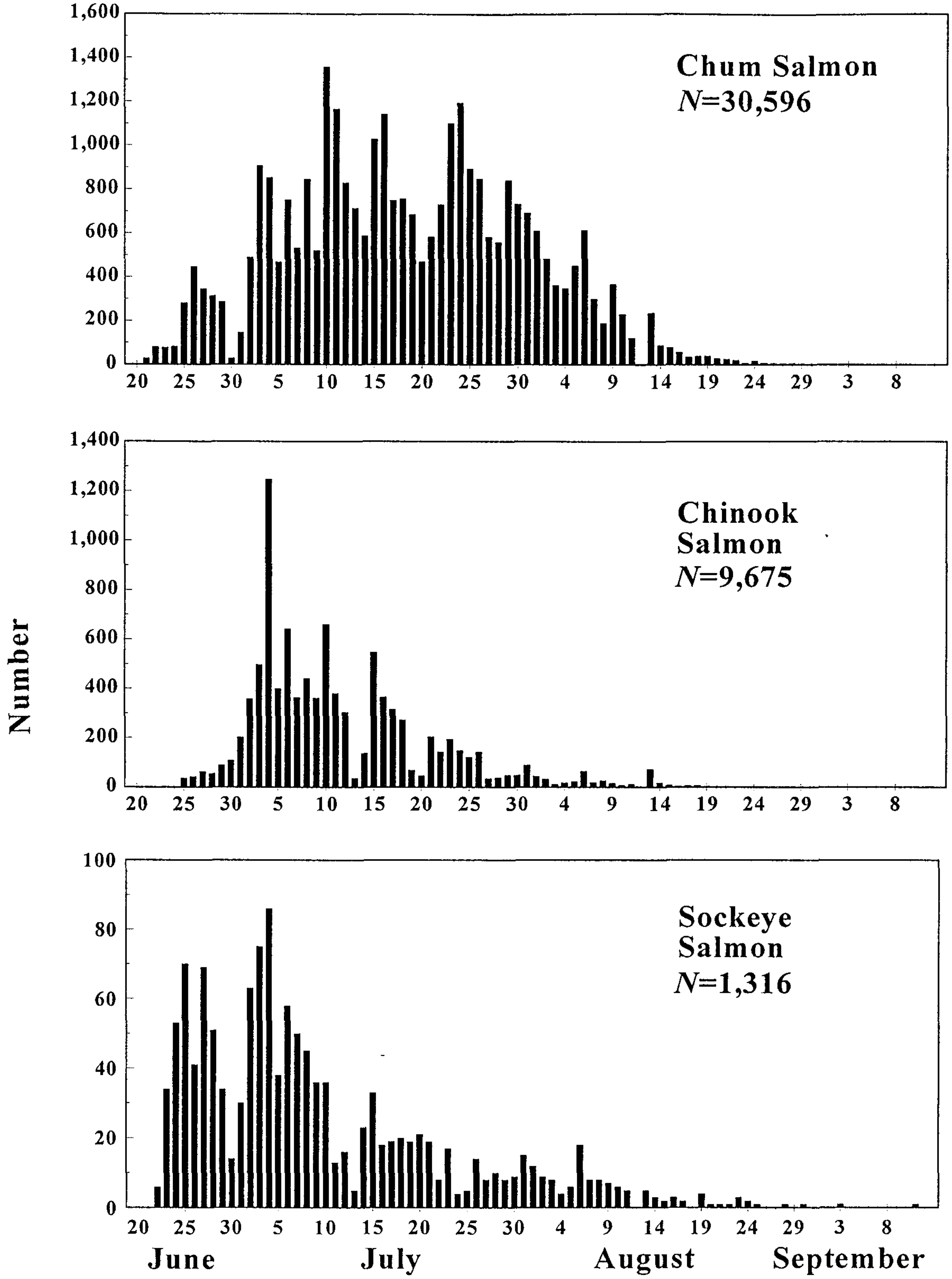


Figure 3.-Daily escapement for five species of salmon passing the Kwethluk River weir from June 20 to September 12, 1992

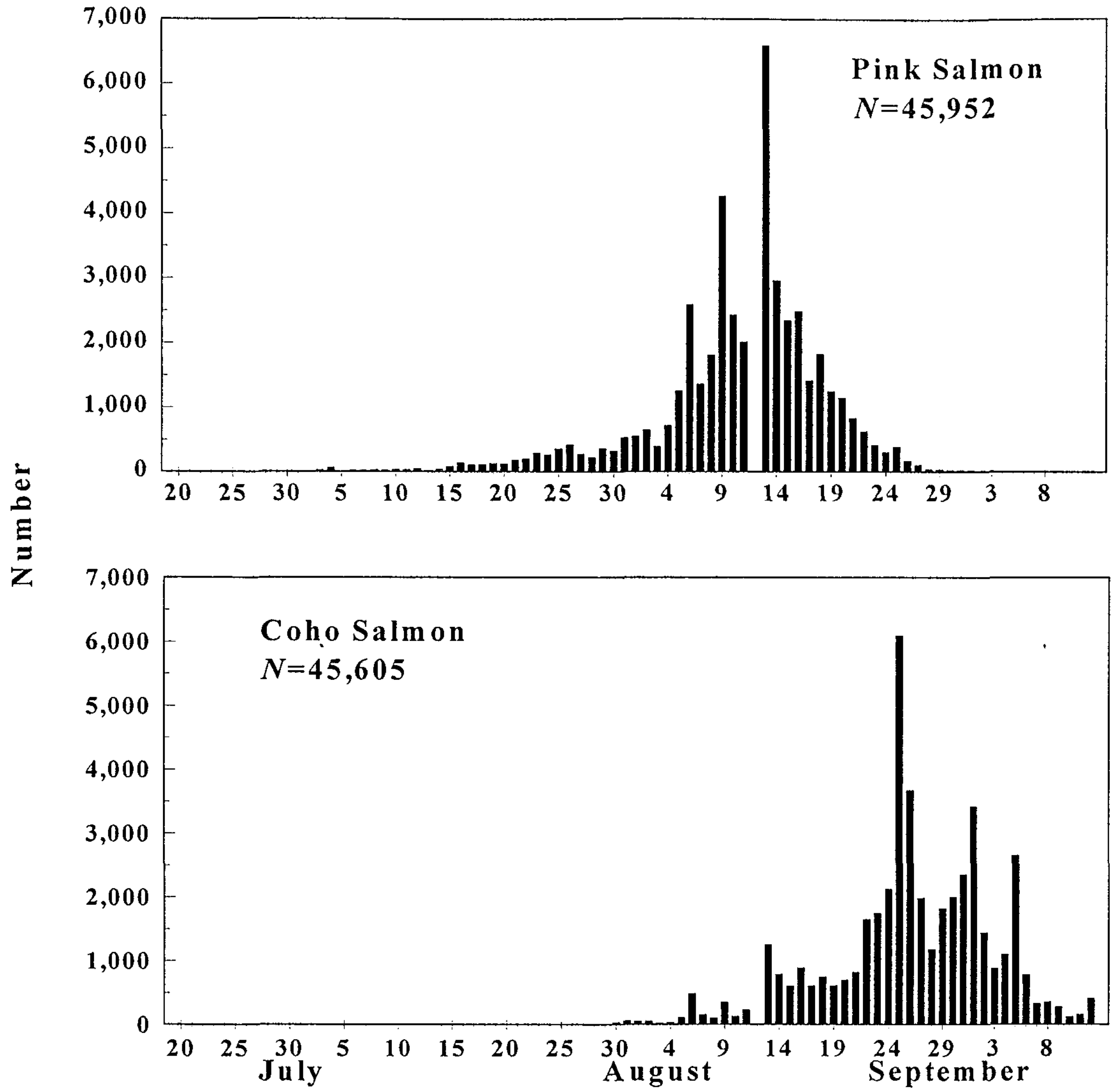


Figure 3-(continued)

June 26, six days after the first chum salmon passed the weir and a total of 8,208 were passed downstream (Appendix 5). The median cumulative day for carcass passage was July 28, 33 days after the first carcass was observed A stream-life of 10 days above the weir was estimated from the median upstream migration day and median downstream passage of carcasses (Figure 6).

Chinook salmon —Chinook salmon was the second species passed through the weir They were first observed starting June 22, and a total of 9,675 passed during the season Peak passage (*N*=3,251) occurred the week of July 5 - 11 (Figure 3) The median cumulative passage day at the weir was July 9, 18 days after the first fish passed (Appendix 4)

A total of 757 chinook salmon were aged and 755 were weighed Age 1 2 was the most prevalent of the eight ages identified in males and age 1 4 was the most prevalent of the six ages identified in females (Table 2). Females composed only 24.8% of the weir escapement, but fluctuated from 38 1% the first week to 21 5% during the peak passage week (Figure 5, Appendix 8).

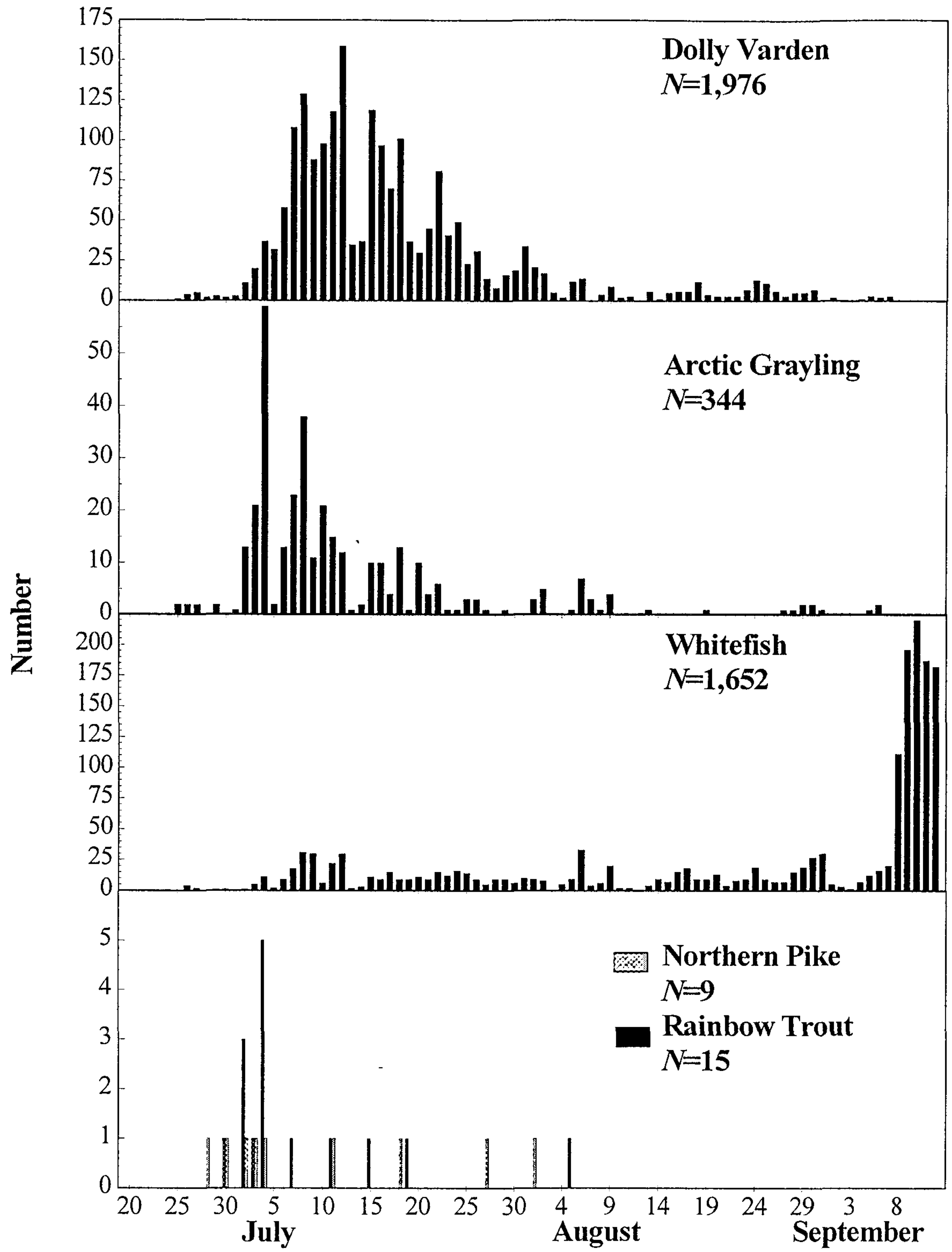


Figure 4 -Resident species counted through the Kwethluk river weir, June 29, to September 12.

TABLE 1 —Length and weight at age for chum salmon sampled at the Kwethluk River weir, 1992

		Length (mm)		Weight (g)	
Age	*N*	Weighted Mean	Range	Weighted Mean	Range
			Female		
0 2	22	496	465 - 540	2,160	1,500 - 3,000
0 3	457	513	380 - 590	2,279	1,200 - 3,800
0 4	205	533	435 - 625	2,658	1,500 - 4,400
0 5	10	543	515 - 605	3,055	2,400 - 3,200
Total	694				
			Male		
0 2	2	535		2,539	
0.3	282	551	460 - 655	3,162	1,500 - 5,200
0.4	225	574	440 - 650	3,678	1,500 - 5,600
0 5	16	573	530 - 635	3,193	2,400 - 4,900
Total	525				

The estimated number of females, based upon the weekly weighted passage, was 2,400. Females were primarily age classes 1.4 (20.9 %) and males were primarily age classes 1.2 (36 2%) and 1 3 (22 5%) of the total weir escapement (Appendix 8). Males predominated in all age classes except 1 4 (Appendix 9) Age composition differed between sexes ($X^2(\hat{\delta}.)$ =51 03, df = 4, $P <$ 0 001) Chinook salmon males in the escapement averaged (weighted mean) 589 mm and 3,976 g and females averaged 851 mm and 11,327 g (Table 2) Female average lengths were longer than males in age classes 1 2 and 2 4 Female average weights were heavier than males in age classes 1 2,1 3,1 4 and 2.4.

Gill-net marks were observed throughout the season on 10% (*N*=970) of the chinook salmon passing the weir (Appendix 3) Carcasses were first observed starting on July 7, 14 days after the first chinook salmon passed upstream (Appendix 5) The median day for cumulative carcass passage (*N*=1,169) was August 5, 29 days after the first carcass (Figure 6, Appendices 4 & 5). A stream-life of 27 days above the weir was estimated from the median upstream migration day and median downstream passage of carcasses (Figure 6, Appendices 4 & 5)

Pink salmon.—Pink salmon passed the weir starting on June 25, continued until September 12 and totaled 45,952 (Figure 3) Peak passage (*N*=20,655) occurred the week of August 9 -15. The median day of upstream passage occurred on August 12 (Appendix 4)

Scales from 41 pink salmon were aged All fish were age 0 1(Table 3) Females (*N*=20) averaged 419 mm and 1,185 g and males (*N*=21) averaged 418 mm and 1,338 g Lengths were similar between sexes (two-tailed *t* test; *t*=0 015, df=36, *P*=0 988)

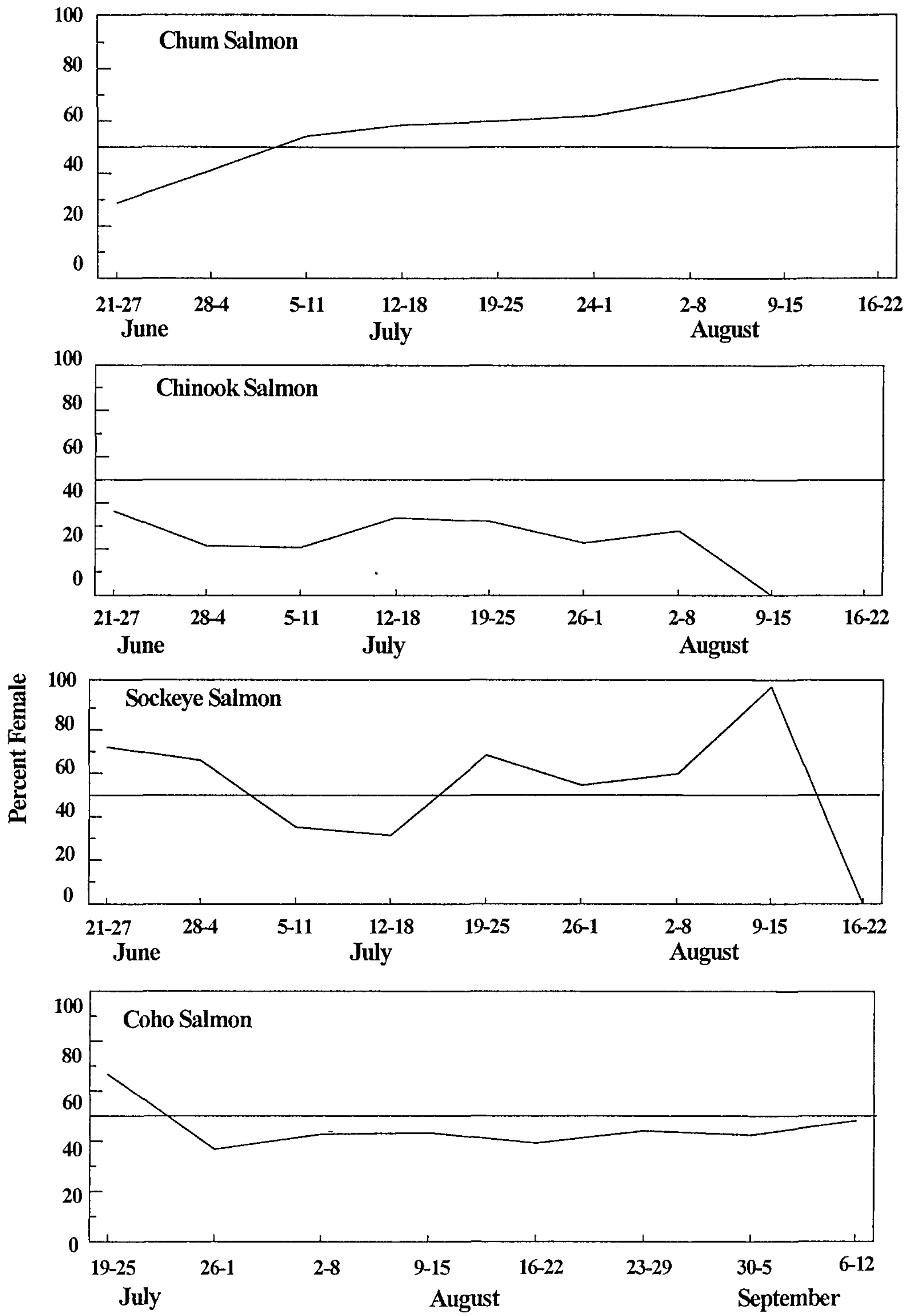


Figure 5.-Weekly sex composition of salmon sampled at the Kwethluk River weir, 1992.

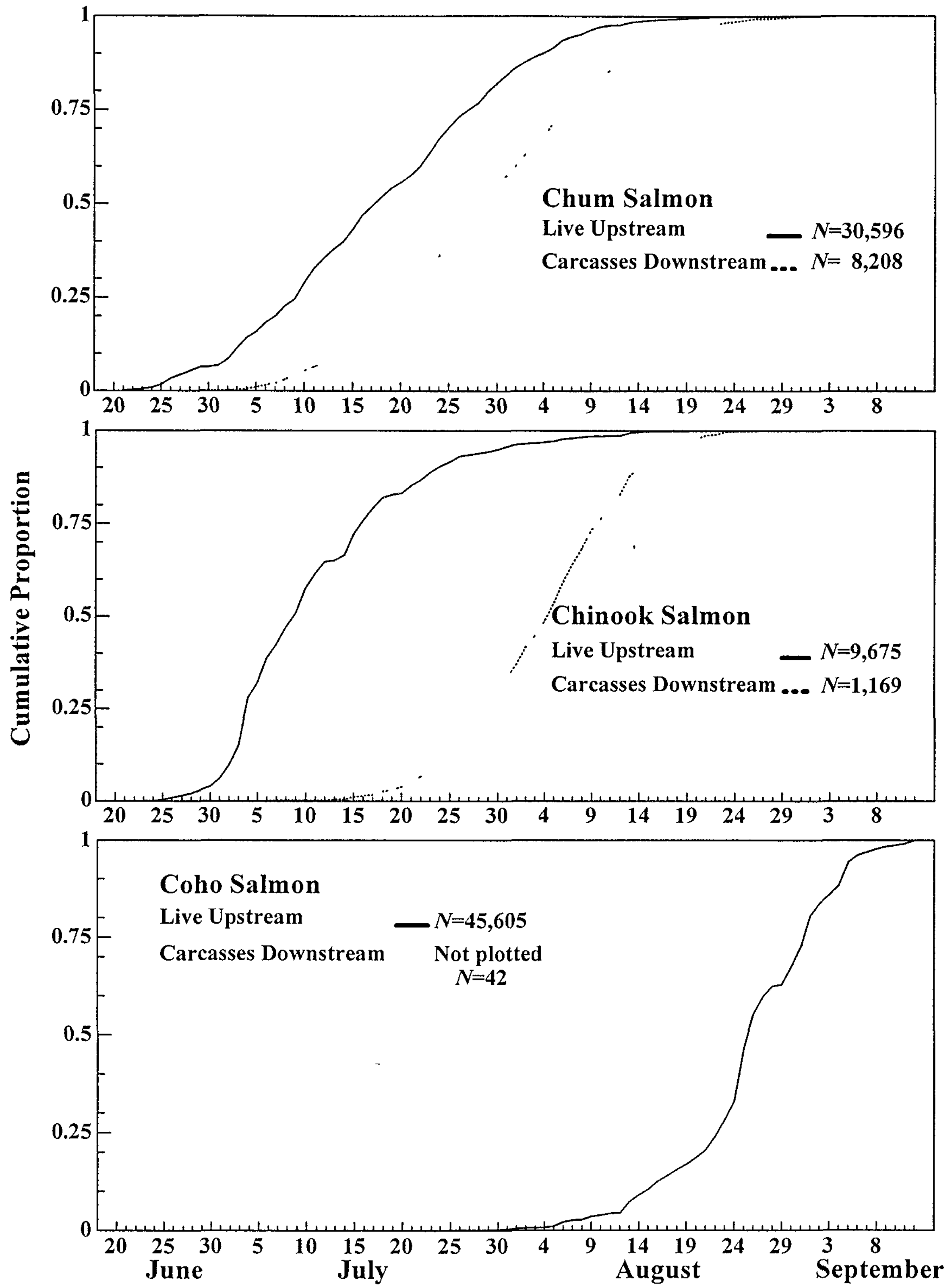


Figure 6 -Comparison of cumulative upstream passage and salmon carcasses passed downstream at the Kwethluk River weir, 1992.

TABLE 2.—Length and weight at age for chinook salmon sampled at the Kwethluk River weir, 1992

Age	*N*	Length (mm) Weighted Mean	Length (mm) Range	Weight (g) Weighted Mean	Weight (g) Range
			Female		
1 2	18	559	455 - 920	3,851	1,800 - 13,100
1 3	20	752	585 - 890	7,827	2,700 - 13,000
1.4	154	874	775 - 975	11,998	7,200 - 17,000
1 5	8	901	820 - 940	12,578	10,400 - 14,600
2 4	1	850	-	9,700	-
Total	200				
			Male		
1.1	76	374	146 - 415	509	200 - 3,500
1.2	247	518	365 - 670	2,724	800 - 6,000
1.3	155	782	380 - 870	5,720	1,000 - 11,900
1 4	66	823	550 -1,050	10,431	3,100 - 21,100
1 5	1	920	-	14,900	-
2 2	6	530	465 - 575	2,621	1,600 - 3,300
2.3	2	603	400 - 690	3,940	1,000 - 5,200
2.4	2	700	655 - 745	5,600	4,500 - 6,700
Total	555				

TABLE 3 —Length and weight at age for pink salmon sampled at the Kwethluk River weir, 1992.

Age	*N*	Length (mm) Mean	Length (mm) SE	Length (mm) Range	Weight (g) Mean	Weight (g) SE	Weight (g) Range
				Female			
0 1	20	419	5	375-480	1,185	0 05	900-1,700
				Male			
0 1	21	418	7	365-495	1,388	0 08	500-2,300

Gill-net marks were observed on 193 pink salmon passing the weir through the end of August (Appendix 3) Pink salmon carcasses totaling 14,674 were past down stream These carcasses were first observed on July 12, which was 18 days after the first live pink salmon was passed upstream (Figure 6) A stream-life of 10 days above the weir was estimated from the median upstream migration day and median downstream passage of carcasses (Figure 6, Appendices 4 & 5)

Sockeye salmon.—Sockeye salmon passed the weir starting June 22, continued until September 11 and totaled 1,316 (Figure 3) Peak passage (N=353) occurred the week of June 28 - July 4 The median of the cumulative upstream migration occurred on July 5, 15 days after the first sockeye salmon passed (Appendix 4).

Eight age classes were identified from 269 sockeye scale samples. Age 1 3 was the most prevalent age class in both males and females (Table 4) Females composed an estimated 59% of the escapement, which fluctuated weekly (Figure 5, Appendix 9). The escapement was composed primarily of age 1 3 (67%) and age 1.2 (15 1%) fish Females age 1.3 (41.6%) comprised the largest percentage of the escapement (Appendix 9). Age composition however did not differ between sexes ($X^2(\hat{\delta}.) = .997$, df = 4, $P < 0.32$)

TABLE 4 —Length and weight at age for sockeye salmon sampled at the Kwethluk River weir, 1992

Age	N	Length (mm) Weighted Mean	Length (mm) Range	Weight (g) Weighted Mean	Weight (g) Range
			Female		
0.2	1	485		2,100	-
0 3	11	492	430 - 545	2,073	1,100 - 3,100
0 4	1	535	-	2,500	-
1 2	15	360	410 - 520	1,673	1,000 - 2,700
1.3	125	628	430 - 570	2,433	1,600 - 3,500
1 4	7	550	525 - 610	3,140	3,000 - 3,700
2 2	2	478	470 - 485	1,750	1,500 - 2,000
2 3	5	510	495 - 525	2,500	2,200 - 2,700
Total 167					
			Male		
0.2	1	390	-	1,100	-
0 3	4	584	550 - 610	3,950	3,200 - 4,500
0 4	2	555	515 - 595	3,550	2,900 - 4,200
1.2	19	438	370 - 550	1,721	1,000 - 3,100
1 3	68	557	460 - 610	3,428	1,500 - 5,200
1 4	3	608	600 - 625	3,850	3,300 - 4,400
2 2	2	525	460 - 590	2,900	1,800 - 4,000
2 3	5	550	485 - 580	3,280	2,200 - 3,900
Total 104					

Sockeye salmon males in the weir escapement (weighted mean) averaged 541 mm and 3,184 g and females averaged 505 mm and 2,332 g In age class 1 2 the weighted average length of males were shorter than females, and in age class 1 3 the weighted average length of females were longer than males Gill-net marks (*N*=80) were observed on approximately 6% of the sockeye salmon passing the weir (Appendix 3). A total of 122 sockeye salmon carcasses were passed downstream (Figure 6) Fifty percent of the carcasses were passed downstream by August 12, 44 days after the first day of carcass passage and 38 days after 50% of the upstream migration had occurred A stream-life of 38 days above the weir was estimated from the median upstream migration day and median downstream passage of carcasses (Figure 6, Appendices 4 & 5).

Coho salmon.—Coho salmon first passed through the weir on July 19 Peak passage (*N*=18,634) occurred the week of August 23, and 45,605 were passed until September 12 (Figure 3; Appendix 10). The last day the weir was operated coho salmon were still passing at the rate of N=413. The median cumulative weir passage occurred on August 26, 39 days after the first coho salmon was passed (Appendix 4).

Three age classes were identified from 734 scale samples (Table 5) Age 2.1 was the most abundant in both sexes. Females composed 42 5% of the weir escapement (Appendix 10). Females and males in age class 2.1 composed 46 9% and 36 3%, respectively, of the weir escapement (Appendix 10). Age composition did not differ between sexes ($X^2(\hat{\delta})$ = 1.594, df = 2, P=0 206)

Coho salmon males in the escapement (weighted mean) averaged 565 mm and 3,574 g and females 559 mm and 3,276 g Very little difference was noted in the weighted average length of the three age classes (Table 5)

Gill-net marks (*N*=1,456) were found on about 3% of the coho salmon sampled Because only 42 coho salmon carcasses were passed downstream, stream-life above the weir was not estimated

TABLE 5.—Length and weight at age for coho salmon sampled at the Kwethluk River weir, 1992.

		Length (mm)		Weight (g)	
Age	*N*	Weighted Mean	Range	Weighted Mean	Range
			Female		
1 1	37	561	480 - 610	3,341	1,500 - 4,200
2 1	255	558	400 - 615	3,269	1,200 - 4,300
3 1	21	575	480 - 600	3,083	1,500 - 4,000
Total 313					
			Male		
1 1	66	562	440 - 625	3,527	800 - 4,500
2.1	344	565	375 - 640	3,574	600 - 5,800
3 1	11	568	475 - 610	3,702	1,900 - 4,700
Total 421					

Gill-net marks (N=1,456) were found on about 3% of the coho salmon sampled Because only 42 coho salmon carcasses were passed downstream, stream-life above the weir was not estimated

Other species—Resident fish sampled incidentally to salmon included whitefish, Arctic grayling, Dolly Varden, northern pike and rainbow trout (Appendix 6) Humpback and round whitefish (N=1,652) moved upstream past the weir throughout the operational period but peaked with more than 200 fish per day in early September (Figure 4) Whitefish that passed through the trap were classified only as whitefish unless they were individually examined. Sampled humpback whitefish (N=10) averaged 412 mm (361-459 mm) Ages were determined from otoliths (N=7) and ranged from 5-7 years Thirty-one sampled round whitefish averaged 417 mm (325-469 mm). Otolith ages (N=30) ranged from 6-12 years. Weights of six samples averaged 838 g (250-1,300 g). Broad whitefish *Coregonus nasus* was found in the drainage during a previous survey (Alt 1977), but was not identified during this study

A total of 344 Arctic grayling were counted and most passed the weir in early July (Figure 4). Sampled Arctic grayling (N=18) averaged 375 mm (265-480 mm) and 608 g (400-700 g) Ages were determined from otoliths (N=11) and ranged from 6-10 years

A total of 1,976 Dolly Varden were counted and most moved upstream in July (Figure 4). Lengths were collected from 184 Dolly Varden and averaged 476 mm (387-597 mm) and weights of 166 fish averaged 1,144 g (400-2,600 g) Ages were determined from otoliths (N=16) and ranged from 5-8 years

Nine northern pike were enumerated and lengths averaged 597 mm (480-637 mm) Weights from two fish, 625 and 637 mm, were 2,000 and 2,200 g, respectively Ages from scales (N=5) ranged from 5-8 years

A total of 15 rainbow trout were counted through the weir Most moved upstream in late June and early July. Lengths of nine fish ranged from 358-460 mm. Weights were measured from two fish, a 425-mm specimen weighing 900 g and a 358-mm specimen weighing 500 g Ages using otoliths (N=6) ranged from 4-6 years

Stream-life

A large percentage of the salmon passed upstream washed down on the weir after spawning Salmon carcasses passing downstream represented the following percentages of upstream passages: Chum 26%, chinook 12%, sockeye 9%, and pink salmon 31%. The estimated stream-life above the weir was 10 days for chum salmon, 27 days for chinook salmon, 38 days for sockeye salmon, and 10 days for pink salmon (Figure 6)

Discussion

The spacing between pickets (3.5 cm) allowed smaller (<340 mm) fish to pass undetected. Identification of whitefish to species required individual examination and most were classified as whitefish Escapement data do not include salmon returning to the Atchenlungik River or several small tributaries found below the weir

Weir Operations

When high water occurred during September, the weir reached its physical limitation of water passage, and pickets were submerged. Only two coho salmon were observed to pass over the weir during this event, and 7,204 were counted through the trap However, observations were only conducted for approximately 2 hours each day and were not attempted during the night Boats passing up and down-stream damaged the boat passage panels that were subsequently modified by bolting plywood to the topside of the panels where boats would contact the weir pickets

Resolutions opposing the weir were passed by local residents in September 1992 Several meetings were held with the Kwethluk village councils during the winter of 1992-93 to gain their support for continuation of the project. Local residents expressed concerns that the weir was killing fish and polluting the river. These concerns were caused by the large number of dead fish visible below the weir Discussions at village meetings centered around two variables that were responsible for the perception. Post spawning pink salmon started to die off in high numbers and were passed downstream Dropping water levels allowed salmon carcasses to accumulate along the river banks and in the deeper pools below the weir for approximately one mile These negotiation efforts failed and the enumeration project was abandoned

Biological Data

A total of 137,140 salmon and resident fish passed the weir during an 85-day period between June 21 and September 12. The weir and trap were closed August 12 due to a crew change, and no fish were passed that day. Because only one year's data has been collected, it should not be assumed that timing and run size are typical

Chum salmon —The weir escapement of 30,596 chum salmon in 1992 was four times greater than the aerial index objective of 7,000 By comparison, the chum salmon run in the Kwethluk River was more than twice the largest return counted past the Tuluksak River weir from 1991 to 1994 (Harper 1997). Escapement counts in 1992 were similar to those found in the Kogrukluk River where they have averaged 37,050 from 1980-1990 (Burkey 1991; Francisco et al 1993)

Female chum salmon made up 57% of the fish passing the weir but only 49% of the 1992 Kuskokwim River commercial fishery harvest (Francisco et al. 1993) Males predominated the first half of the escapement followed by females after the mid point in the escapement. This was similar to the escapement pattern in the Tuluksak River (Harper 1997) and in the commercial fisheries (Francisco et al 1993)

Ages switched from predominately 0 4 chum salmon during the first several weeks to age 0.3 This trend was also found on the Tuluksak River between 1991 and 1994

Gill-net marks were found on 3% of the sampled chum salmon in the Kwethluk River This was less than the 4% found at the Tuluksak River weir in 1992 (Harper 1995b) The median day of carcass passage was July 27, which was earlier than the range of median days found on the Tuluksak River (Harper 1997)

Chinook salmon —The 1992 weir escapement of 9,675 chinook salmon was almost five times larger than the numbers found in aerial index surveys flown between 1960 and 1992 (Appendix 1) The median cumulative passage date at the weir occurred on July 9 (Figure 5).

Female chinook salmon comprised a larger proportion (24 8%) of the 1992 Kwethluk River weir escapement than the 14 8% found the same year in the Tuluksak River (Harper 1997) In comparison female chinook salmon comprised 22 6% of the Kuskokwim River commercial catch in 1992 and averaged 27.7% from 1985 to 1994 (Francisco et al. 1995) Female chinook salmon comprised 33 3% of the Kogrukluk River weir escapement in 1992 where returns have ranged from 17 6% to 47.2% females and averaged 31 8% from 1985-1994

The weekly percentage of female chinook salmon passing the Kwethluk River weir fell during the peak of the escapement (Figure 5). This fluctuation also occurred each year during the escapement peak on the Tuluksak River (Harper 1997) Weekly percentages of females however increased during the later part of the Tuluksak River weir escapement in 1991 and 1994, but remained low in 1992 and 1993 The low percentage of females in the Kwethluk River weir escapement is of concern and may be due to several factors, such as. 1) Females return at older ages than males and incur additional years of ocean mortality (Hankin and Healy 1986) 2) The subsistence fishery may also harvest a high proportion of the large sized females since the subsistence fishery does not have a mesh size restriction (Francisco et al 1991) 3) Fewer female chinook salmon would reach the Kwethluk River if intensive commercial and subsistence fishing effort coincided with the run timing of this stock

Gill-net marks comprised 21.2% of the sampled females and only 5.9% for males By comparison female chinook salmon passing the Tuluksak River weir with net marks between 1991 and 1994 were; 8 6%, 21 0%, 12.8%, and, 16 0% respectively (Harper 1997) The higher percentage of net marks on females in 1992 in both rivers may have resulted from several factors. 1) Four commercial openings for chum salmon occurred before June 30 in 1992. Because most of the chinook salmon run passes through the lower Kuskokwim River before July, chum salmon commercial openings during June will result in a larger incidental harvest of chinook salmon. During this time, some chinook salmon encountering smaller mesh size nets in the commercial and subsistence fisheries will escape and resume their migration. 2) Changes in the methods, means or timing of the subsistence fishery in the lower Kuskokwim River may have occurred in 1992

Pink salmon —Kuskokwim River pink salmon have strong even year runs and commercial catches averaged 3,948 for even years and 217 for odd years since 1980 (Francisco et al. 1992) Escapement goals have not been established for pink salmon in the Kuskokwim River drainage. The 1992 weir escapement of 45,952 was larger than the 1992 passage at the Tuluksak River weir of 2,470 The median of the cumulative passage occurred August 12 and was later than the median of August 7 found on the Tuluksak River in 1992

Sockeye salmon —The number of sockeye salmon passing the Kwethluk River weir was only 1,316 fish in 1992. Small lakes that may be suitable as rearing habitat for juvenile sockeye salmon are scattered throughout the drainage The small run probably indicates habitat is limited and actual spawning and rearing locations have not been determined.

Coho salmon.—The weir escapement of 45,605 coho salmon in 1992 exceeded the largest return to the Tuluksak River between 1991 and 1994 (Harper 1997) Commercial catches per opening in the lower Kuskokwim River have ranged from 2,489 to 181,905. Timing of very large harvests may heavily impact returns to individual tributaries like the Kwethluk River.

The percentage of coho salmon with gill-net marks in 1992 was 3%, (1,456). This percentage was lower than gill-net marks found at the Tuluksak River weir where 9 4%, 5.4%, 4 6% and 3.4% were found between 1991 and 1994 (Harper 1995a,b,c; Harper 1997). Only 43 coho salmon carcasses were passed downstream during weir operations

Other species—The movement of Arctic grayling, northern pike, and rainbow trout appeared to be in response to spawning salmon and the availability of eggs as a food source. Whitefish that moved early in the season were also probably moving in response to the spawning salmon. Whitefish moving in September were probably moving upstream to spawn.

Stream-life

Salmon stream-life can be used to detect when peak numbers of salmon are present on the spawning grounds and used as a guide for timing aerial index surveys. Using the difference between the median cumulative passage date to estimate stream-life may result in a biased estimate Nielson and Geen (1981), found residence time on redds to vary throughout the season Salmon arriving early generally spent a longer period on a redd than late arrivals Rising water levels may also wash fish downstream faster than normal, or declining water levels may slow carcass return or strand them on river banks Spawning also occurs at varying distances above the weir, and carcasses may sink to the bottom before reaching the weir Carcasses, however, represented up to 1/3 of the up-stream passage of all salmon counted through the weir

Aerial index surveys must account for stream-life and run timing to provide useful data. Species, like chum salmon, with a short stream-life and extended escapements should be surveyed more than once and the "Factor 5" or "Area Under the Curve" methods described by Cousins et al. (1982) should be used to estimate total abundance. When 90% of the chum salmon had entered the river, more than 60% of the carcasses had been passed downstream. Species with a long stream-life and short immigration time such as chinook salmon can be surveyed once, observing most spawners. During 1992 approximately 91% of the chinook salmon had passed the weir by July 25, and only 1% of the carcasses had been passed downstream. Aerial index surveys flown later would miss fish because a higher percentage of fish would have passed downstream as carcasses. For example during the aerial index survey flown on July 29 only 69% of the weir escapement was available for enumeration because 25% of the carcasses were passed down over the weir by that date.

Escapement data from 1992 suggest the optimal time to conduct aerial index surveys for coho salmon would be the first week of September Seventy to 90% of the coho salmon had entered the river by this date Very few carcasses were counted downstream by then.

Funding, weather, and water conditions on the Kwethluk River, however, have made it impossible to collect useable aerial survey data for chum and chinook salmon for 15 of the 33 years from 1960 to 1992 Better methods such as weirs are therefore needed for estimating escapements, and monitoring the quality of the escapement

Recommendations

Based upon the data in this report and personal observations, the following is recommended.

1. Because of increasing competing demands on the fishery from commercial, subsistence, and sport fisheries, it is important to monitor lower Kuskokwim River tributary escapements on the refuge A weir or other monitoring operation that can gather age and sex information should be continued for at least one full life cycle of chinook salmon This should be the minimal amount of data used to detect if the low sex ratios for chinook salmon are cyclical. Low numbers of female chinook salmon entering the river signals the need for a monitoring program and a change in regulations and escapement goals if females continue to return in such low numbers.

2. Determine the river's carrying capacity by quantifying spawning and rearing habitat to establish a biological escapement goal for chinook, chum and coho salmon

3 Additional information needs to be gathered on the subsistence fishery, including mesh sizes used and age and sex of the harvest.

Acknowledgments

Special appreciation is extended to those people who contributed to this project John Tobin, the crew leader, is given special recognition for designing many of the weir components, data collection, and day to day weir operation. John Tobeluk also deserves special credit for his efforts as interim crew leader Brad Benter served as the crew leader at the end of the season, and helped to remove the weir Co-workers Doug Palmer and Jeff Booth, Student Conservation Volunteers Chris Abbes, Joe Kelly and Tim Roettiger, and Resource Apprentice Student Carl Napoka, Jr all contributed to the success of the project. Anne Barrett deserves special credit for her patience in the typing of this manuscript and drawing of figures, as does Janet Rumble, Service volunteer for data entry and the drawing of figures.

A special thanks to the Yukon Delta National Wildlife Refuge staff Ron Perry, Denny Strom, John Morgart, Mike Jensen and Mildred Prince and many others deserve special mention for their help and assistance We also appreciate the help and assistance of the Alaska Department of Fish and Game (Commercial Fish Division, Bethel Office) and to Doug Molyneaux for pressing and aging of salmon scales

References

Alt, K 1977 Inventory and cataloging in western Alaska waters Alaska Department of Fish and Game, Federal Aid in Fish Restoration Completion Report, Study G-I-P, Volume 18, Juneau, Alaska

Burkey, C 1991 Kogrukluk weir escapement report, 1990 Alaska Department of Fish and Game, Division of Commercial Fisheries, AYC Region, Regional Information Report No 3B91-19, Anchorage, Alaska

Cochran, W G 1977 Sampling techniques, third edition. John Wiley and Sons, New York

Cousins, N B F , G A Thomas, C G Swann, and M C Healey 1982 A review of salmon escapement estimation techniques Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, British Columbia

Francisco, K R , C Burkey, D Molyneaux, C Anderson, H Hamner, K Hyer, M Coffing, and C Utermohle 1991 Annual management report Kuskokwim area, 1990 Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report 3A91-11, Anchorage, Alaska

Francisco, K R , C Anderson, C Burkey, M Coffing, K Hyer, D Molyneaux, and C Utermohle 1992 Annual management report for the subsistence and commercial fishery of the Kuskokwim area, 1991 Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report 3A92-06, Anchorage, Alaska

Francisco, K R , C Burkey, D Molyneaux, C Anderson, H Hamner, K Hyer, M. Coffing, and Charles Utermohle 1993 Annual management report for the subsistence and commercial fisheries of the Kuskokwim area, 1992 Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report Number 3B93-11, Anchorage, Alaska

Francisco, K R , C Anderson, C Burkey, M Fogarty, D Molyneaux, C Utermohle, K. Vaught. 1995 Annual management report for the subsistence and commercial fisheries of the Kuskokwim area, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report Number 3B95-15, Anchorage, Alaska

Geiger, J H , J E Clark , B Cross, and S McPherson 1990 Report from the work group on sampling Pages 3-12 *in* H J. Geiger, and R L Wilbur, editors Proceedings of the 1990 Alaska Stock Separation Workshop. Alaska Department of Fish and Game, Division of Commercial Fisheries Special Fisheries Report No 2, Juneau, Alaska.

Hamilton K , and E P Bergersen 1984 Methods to estimate aquatic habitat variables Colorado State University, Colorado Cooperative Fishery Research Unit, Ft Collins, Colorado

Hankin D G and M C Healy 1986 Dependence of exploitation rates for maximum yield and stock collapse of age and sex structures of chinook salmon (*Oncorhynchus tshawytscha*) stocks Canadian Journal of Fisheries and Aquatic Sciences Vol 43 1746-1759

Refrences (continued)

Harper, K C 1995a Run timing and abundance of adult salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 1991 U S Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Progress Report, 95-1, Kenai, Alaska

Harper, K C 1995b Run timing and abundance of adult salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 1992. U S Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Progress Report, 95-3, Kenai, Alaska.

Harper, K C 1995c. Run timing and abundance of adult salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 1993. U S Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Progress Report, 95-2, Kenai, Alaska.

Harper, K C 1997 Run timing and abundance of adult salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 1994 U.S Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 41, Kenai, Alaska

Koo, T.S Y 1962 Age determination in salmon Pages 37-48 *in* T S Y Koo, editor Studies of Alaska red salmon University of Washington Press, Seattle, Washington

Mosher, K H 1968 Photographic atlas of sockeye salmon scales U S Fish and Wildlife Service, Bureau of Commercial Fisheries, Fishery Bulletin 2 243-274

Mundy, P.R 1982 Computation of migratory timing statistics for adult chinook salmon in the Yukon River, Alaska, and their relevance to fishery management North American Journal of Fisheries Management 4 359-370

Nielson, J D , and G H Geen 1981 Enumeration of spawning salmon from spawner residence time and aerial counts Transactions of the American Fisheries Society 110 554-556

Rao, J N K and D R Thomas 1989 Chi-squared test for contingency tables Pages 89-114 *In* C J Skinner, D Holt, and T M F Smith editors Analysis of complex surveys John Wiley & Sons, New York, New York

Schneiderhan, D 1979 1978 Kuskokwim River sonar studies Alaska Yukon-Kuskokwim Region Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim River Escapement Report Number 16, Anchorage, Alaska

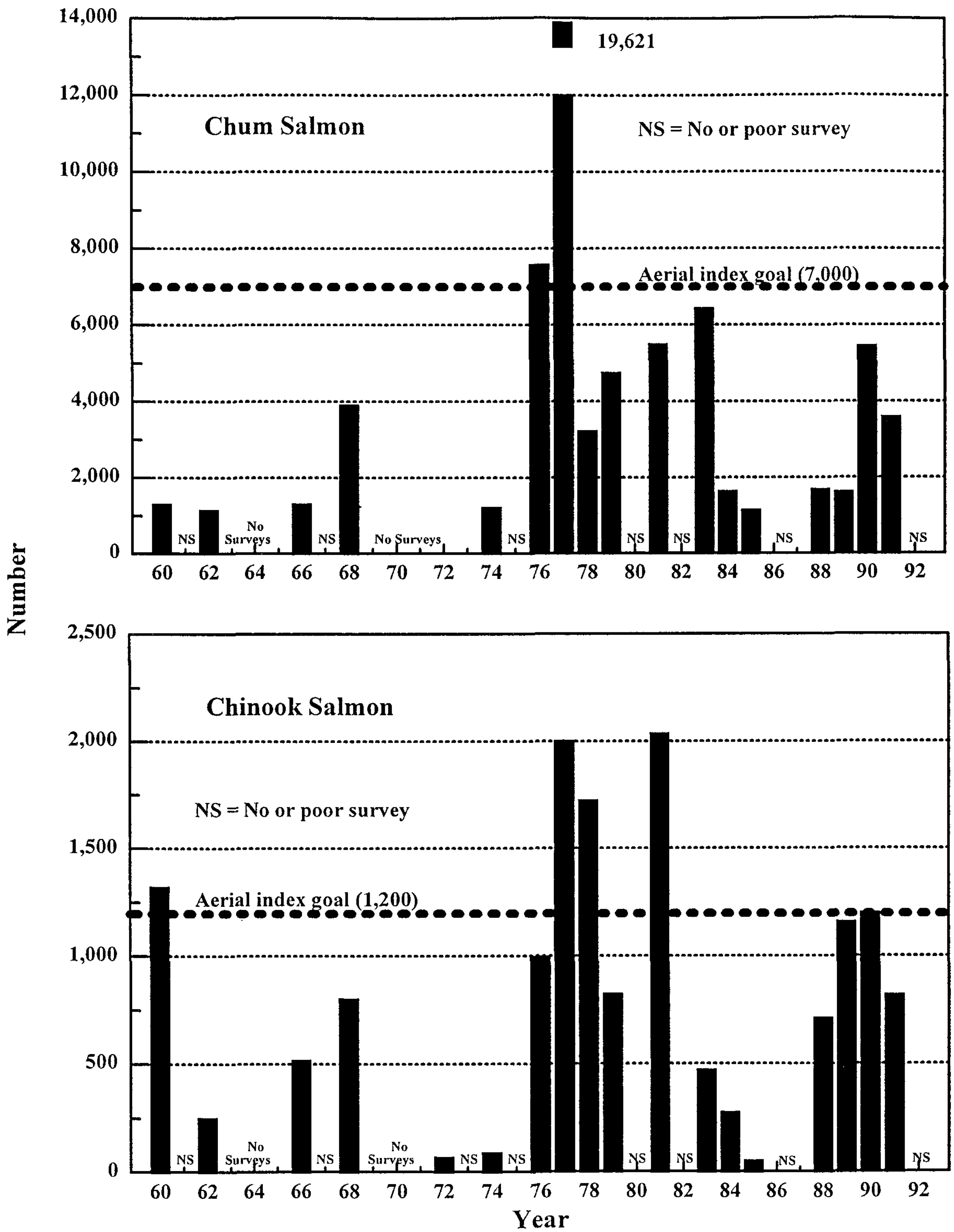
Schneiderhan, D 1983 Kuskokwim stream catalog, 1954-1983 Alaska Department of Fish and Game, unpublished annotated database report, Anchorage, Alaska

Schneiderhan, D 1988 Kuskokwim area salmon escapement observation catalog, 1984-1988 Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Informational Report Number 3B88-29, Anchorage, Alaska.

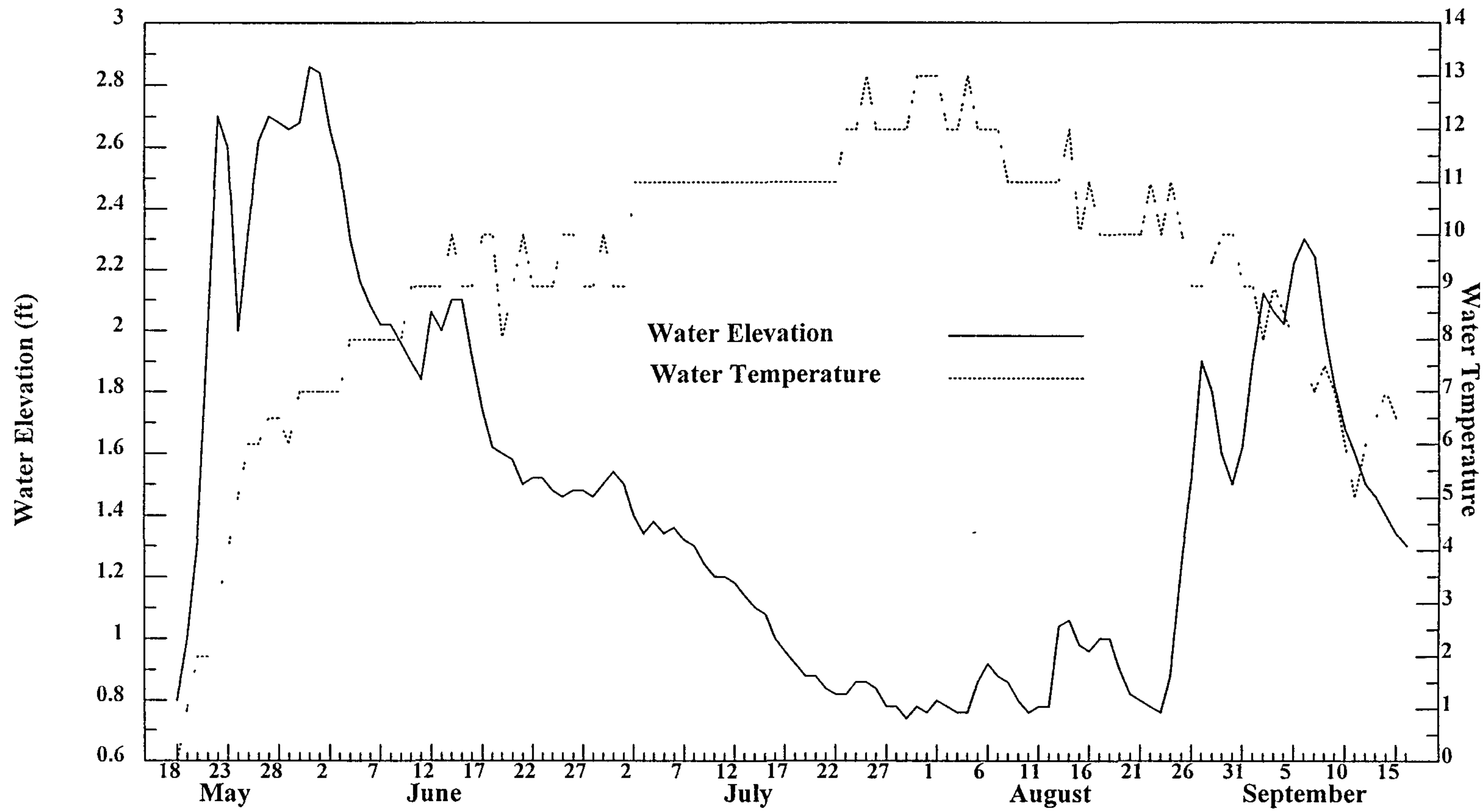
Tobin, J.H. 1994 Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers U S Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Technical Report Number 22, Kenai, Alaska

U S Fish and Wildlife Service 1988 Yukon Delta National Wildlife Refuge comprehensive conservation plan, environmental impact statement, wilderness review, and wild river plan. U S Department of Interior, Fish and Wildlife Service, Anchorage, Alaska

U S Fish and Wildlife Service 1992 Fishery management plan for the Yukon Delta National Wildlife Refuge U S Fish and Wildlife Service, Anchorage, Alaska



APPENDIX 1.–Aerial index surveys for chum and chinook salmon in the Kwethluk River, 1960-1992



APPENDIX 2.–Water levels and temperatures in the Kwethluk River, 1992.

Appendix 3.-Daily weir counts of salmon, gill net marked salmon and resident fish species, Kwethluk River weir, 1992.

						Gill Net Marked									
Date	Chum Salmon	Chinook Salmon	Sockeye Salmon	Pink Salmon	Coho Salmon	Chum Salmon	Chinook Salmon	Sockeye Salmon	Pink Salmon	Coho Salmon	Dolly Varden	Rainbow Trout	Whitefish	Arctic Grayling	Northern Pike
06/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06/21	28	0	0	0	0	3	0	0	0	0	0	0	0	0	0
06/22	82	2	6	0	0	1	0	0	0	0	0	0	0	0	0
06/23	78	3	34	0	0	3	0	3	0	0	0	0	0	0	0
06/24	83	2	53	0	0	3	0	0	0	0	0	0	0	0	0
06/25	281	36	70	1	0	9	2	4	0	0	1	0	0	2	0
06/26	449	42	41	0	0	49	2	1	0	0	4	0	4	2	0
06/27	346	64	69	1	0	16	2	0	0	0	5	0	2	2	0
06/28	314	55	51	1	0	11	1	9	0	0	2	0	0	0	1
06/29	287	89	34	1	0	12	5	5	0	0	3	0	1	2	0
06/30	30	108	14	4	0	2	7	0	0	0	2	1	1	0	1
07/01	147	202	30	7	0	11	12	2	0	0	3	0	0	1	0
07/02	490	358	63	10	0	28	18	2	0	0	11	3	1	13	1
07/03	908	497	75	33	0	69	29	7	0	0	20	1	5	21	1
07/04	855	1248	86	72	0	100	51	6	0	0	37	5	11	59	1
07/05	469	400	38	7	0	34	42	4	0	0	32	0	2	2	0
07/06	754	642	58	20	0	49	66	2	0	0	58	0	9	13	0
07/07	533	364	50	21	0	48	28	2	0	0	108	1	18	23	0
07/08	847	442	45	31	0	73	55	1	0	0	129	0	31	38	0
07/09	522	361	36	25	0	38	58	2	0	0	88	0	30	11	0
07/10	1361	661	36	37	0	114	76	2	0	0	98	0	6	21	0
07/11	1169	381	13	35	0	83	67	0	0	0	118	1	22	15	1
07/12	831	304	16	50	0	70	36	1	0	0	159	0	30	12	0
07/13	716	36	5	20	0	50	7	1	0	0	35	0	2	1	0
07/14	589	137	23	41	0	24	25	2	1	0	37	0	3	2	0
07/15	1031	548	33	88	0	51	100	2	1	0	119	1	11	10	0
07/16	1145	366	18	143	0	48	44	1	0	0	97	0	9	10	0
07/17	751	317	19	109	0	44	33	0	0	0	70	0	15	4	0
07/18	758	273	20	114	0	36	24	0	1	0	101	0	9	13	1
07/19	687	69	19	130	1	16	9	1	0	0	37	1	9	1	0
07/20	470	46	21	123	1	6	7	1	0	0	30	0	11	10	0
07/21	584	205	19	187	7	18	30	2	1	1	45	0	9	4	0
07/22	731	144	8	207	1	16	8	1	0	0	81	0	15	6	0
07/23	1102	195	17	295	5	21	27	0	0	0	41	0	12	1	0
07/24	1196	149	4	269	5	18	20	0	0	0	49	0	16	1	0
07/25	894	122	5	360	8	18	11	0	1	0	23	0	14	3	0
07/26	849	143	14	423	12	19	6	1	0	1	31	0	9	3	0
07/27	583	35	8	282	6	19	1	0	0	0	14	0	5	1	1
07/28	559	39	10	230	8	5	5	1	0	0	8	0	9	0	0
07/29	841	49	8	366	13	9	4	2	0	0	16	0	9	1	0
07/30	733	49	9	331	38	19	7	2	0	3	19	0	6	0	0
07/31	693	89	15	534	67	11	9	0	1	2	34	0	10	0	0

-CONTINUED-

Appendix 3.-(continued)

						Gill Net Marked									
Date	Chum Salmon	Chinook Salmon	Sockeye Salmon	Pink Salmon	Coho Salmon	Chum Salmon	Chinook Salmon	Sockeye Salmon	Pink Salmon	Coho Salmon	Dolly Varden	Rainbow Trout	Whitefish	Arctic Grayling	Northern Pike
08/01	611	44	12	558	57	6	2	2	0	1	21	0	9	3	1
08/02	484	33	9	657	62	6	6	2	0	3	17	0	8	5	0
08/03	363	11	8	399	27	10	0	1	0	1	5	0	0	0	0
08/04	349	18	4	721	40	4	2	0	0	1	2	0	5	0	0
08/05	452	23	6	1261	116	2	0	0	1	1	12	1	9	1	0
08/06	614	65	18	2597	489	10	6	0	1	9	14	0	33	7	0
08/07	301	19	8	1372	159	19	1	0	1	4	5	0	4	3	0
08/08	190	26	8	1817	106	3	8	0	0	0	4	0	6	1	0
08/09	368	16	7	4271	355	46	3	0	10	7	9	0	20	4	0
08/10	231	7	6	2437	133	2	0	1	0	3	2	0	2	0	0
08/11	123	11	5	2020	237	1	1	1	4	5	3	0	2	0	0
08/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/13	238	72	5	6601	1255	17	3	2	30	29	6	0	4	1	0
08/14	90	18	3	2970	793	3	1	0	0	15	1	0	9	0	0
08/15	80	8	2	2356	609	7	1	0	4	12	5	0	7	0	0
08/16	59	4	3	2496	894	6	1	0	13	34	6	0	15	0	0
08/17	37	6	2	1422	616	5	0	0	7	22	6	0	18	0	0
08/18	40	7	0	1833	752	10	1	0	34	20	12	0	9	0	0
08/19	41	3	4	1257	612	4	0	0	12	28	4	0	9	1	0
08/20	30	3	1	1156	701	5	0	0	14	25	3	0	13	0	0
08/21	26	3	1	838	822	2	0	0	4	31	3	0	4	0	0
08/22	21	0	1	633	1651	1	0	0	9	30	3	0	8	0	0
08/23	9	0	3	417	1748	0	0	1	10	35	7	0	9	0	0
08/24	17	3	2	309	2125	1	0	0	5	46	13	0	19	0	0
08/25	8	0	1	394	6099	1	0	0	17	127	11	0	9	0	0
08/26	6	0	0	175	3677	0	0	0	8	86	6	0	7	0	0
08/27	5	0	0	111	1984	0	0	0	2	56	3	0	7	1	0
08/28	7	0	1	40	1181	1	0	0	1	40	5	0	15	1	0
08/29	4	1	0	41	1820	0	0	0	0	55	5	0	19	2	0
08/30	4	0	1	33	2003	0	0	0	.0	83	7	0	27	2	0
08/31	2	0	0	31	2353	0	0	0	0	84	0	0	30	1	0
09/01	2	0	0	19	3425	0	0	0	0	106	2	0	5	0	0
09/02	0	0	0	17	1443	0	0	0	0	52	0	0	3	0	0
09/03	2	0	1	17	881	0	0	0	0	39	0	0	1	0	0
09/04	2	1	0	12	1102	0	0	0	0	45	1	0	7	0	0
09/05	0	0	0	14	2654	0	0	0	0	136	3	0	12	1	0
09/06	0	0	0	12	781	0	0	0	0	51	2	0	16	2	0
09/07	2	0	0	17	331	0	0	0	0	25	3	0	20	0	0
09/08	0	0	0	7	357	0	0	0	0	26	0	0	111	0	0
09/09	1	0	0	3	282	0	0	0	0	16	0	0	196	0	0
09/10	0	1	0	1	128	0	0	0	0	6	0	0	220	0	0
09/11	0	0	1	1	160	0	0	0	0	17	0	0	187	0	0
09/12	0	0	0	1	413	0	0	0	0	37	0	0	182	0	0
	30595	9675	1316	45952	45605	1446	970	80	193	1456	1976	15	1652	344	9

Appendix 4.-Daily weir counts and cumulative proportions of chum, chinook, sockeye, pink and coho salmon, Kwethluk River weir, 1992.

	Chum Salmon		Chinook Salmon		Sockeye Salmon		Pink Salmon		Coho Salmon	
	Cumulative		Cumulative		Cumulative		Cumulative		Cumulative	
Date	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion
06/20	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/21	28	0.0009	0	0.0009	0	0.0009	0	0.0009	0	0.0009
06/22	110	0.0036	2	0.0036	6	0.0036	0	0.0036	0	0.0036
06/23	188	0.0061	5	0.0061	40	0.0061	0	0.0061	0	0.0061
06/24	271	0.0089	7	0.0089	93	0.0089	0	0.0089	0	0.0089
06/25	552	0.0180	43	0.0180	163	0.0180	1	0.0180	0	0.0180
06/26	1001	0.0327	85	0.0327	204	0.0327	1	0.0327	0	0.0327
06/27	1347	0.0440	149	0.0440	273	0.0440	2	0.0440	0	0.0440
06/28	1661	0.0543	204	0.0543	324	0.0543	3	0.0543	0	0.0543
06/29	1948	0.0637	293	0.0637	358	0.0637	4	0.0637	0	0.0637
06/30	1978	0.0647	401	0.0647	372	0.0647	8	0.0647	0	0.0647
07/01	2125	0.0695	603	0.0695	402	0.0695	15	0.0695	0	0.0695
07/02	2615	0.0855	961	0.0855	465	0.0855	25	0.0855	0	0.0855
07/03	3523	0.1151	1458	0.1151	540	0.1151	58	0.1151	0	0.1151
07/04	4378	0.1431	2706	0.1431	626	0.1431	130	0.1431	0	0.1431
07/05	4847	0.1584	3106	0.1584	664	0.1584	137	0.1584	0	0.1584
07/06	5601	0.1831	3748	0.1831	722	0.1831	157	0.1831	0	0.1831
07/07	6134	0.2005	4112	0.2005	772	0.2005	178	0.2005	0	0.2005
07/08	6981	0.2282	4554	0.2282	817	0.2282	209	0.2282	0	0.2282
07/09	7503	0.2452	4915	0.2452	853	0.2452	234	0.2452	0	0.2452
07/10	8864	0.2897	5576	0.2897	889	0.2897	271	0.2897	0	0.2897
07/11	10033	0.3279	5957	0.3279	902	0.3279	306	0.3279	0	0.3279
07/12	10864	0.3551	6261	0.3551	918	0.3551	356	0.3551	0	0.3551
07/13	11580	0.3785	6297	0.3785	923	0.3785	376	0.3785	0	0.3785
07/14	12169	0.3977	6434	0.3977	946	0.3977	417	0.3977	0	0.3977
07/15	13200	0.4314	6982	0.4314	979	0.4314	505	0.4314	0	0.4314
07/16	14345	0.4689	7348	0.4689	997	0.4689	648	0.4689	0	0.4689
07/17	15096	0.4934	7665	0.4934	1016	0.4934	757	0.4934	0	0.4934
07/18	15854	0.5182	7938	0.5182	1036	0.5182	871	0.5182	0	0.5182
07/19	16541	0.5406	8007	0.5406	1055	0.5406	1001	0.5406	1	0.5406
07/20	17011	0.5560	8053	0.5560	1076	0.5560	1124	0.5560	2	0.5560
07/21	17595	0.5751	8258	0.5751	1095	0.5751	1311	0.5751	9	0.5751
07/22	18326	0.5990	8402	0.5990	1103	0.5990	1518	0.5990	10	0.5990
07/23	19428	0.6350	8597	0.6350	1120	0.6350	1813	0.6350	15	0.6350
07/24	20624	0.6741	8746	0.6741	1124	0.6741	2082	0.6741	20	0.6741
07/25	21518	0.7033	8868	0.7033	1129	0.7033	2442	0.7033	28	0.7033
07/26	22367	0.7311	9011	0.7311	1143	0.7311	2865	0.7311	40	0.7311
07/27	22950	0.7501	9046	0.7501	1151	0.7501	3147	0.7501	46	0.7501
07/28	23509	0.7684	9085	0.7684	1161	0.7684	3377	0.7684	54	0.7684
07/29	24350	0.7959	9134	0.7959	1169	0.7959	3743	0.7959	67	0.7959
07/30	25083	0.8198	9183	0.8198	1178	0.8198	4074	0.8198	105	0.8198
07/31	25776	0.8425	9272	0.8425	1193	0.8425	4608	0.8425	172	0.8425

-CONTINUED-

Appendix 4.-(continued)

	Chum Salmon		Chinook Salmon		Sockeye Salmon		Pink Salmon		Coho Salmon	
	Cumulative		Cumulative		Cumulative		Cumulative		Cumulative	
Date	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion	Escapement	Proportion
08/01	26387	0.8625	9316	0.8625	1205	0.8625	5166	0.8625	229	0.8625
08/02	26871	0.8783	9349	0.8783	1214	0.8783	5823	0.8783	291	0.8783
08/03	27234	0.8901	9360	0.8901	1222	0.8901	6222	0.8901	318	0.8901
08/04	27583	0.9016	9378	0.9016	1226	0.9016	6943	0.9016	358	0.9016
08/05	28035	0.9163	9401	0.9163	1232	0.9163	8204	0.9163	474	0.9163
08/06	28649	0.9364	9466	0.9364	1250	0.9364	10801	0.9364	963	0.9364
08/07	28950	0.9462	9485	0.9462	1258	0.9462	12173	0.9462	1122	0.9462
08/08	29140	0.9524	9511	0.9524	1266	0.9524	13990	0.9524	1228	0.9524
08/09	29508	0.9645	9527	0.9645	1273	0.9645	18261	0.9645	1583	0.9645
08/10	29739	0.9720	9534	0.9720	1279	0.9720	20698	0.9720	1716	0.9720
08/11	29862	0.9760	9545	0.9760	1284	0.9760	22718	0.9760	1953	0.9760
08/12	29862	0.9760	9545	0.9760	1284	0.9760	22718	0.9760	1953	0.9760
08/13	30100	0.9838	9617	0.9838	1289	0.9838	29319	0.9838	3208	0.9838
08/14	30190	0.9868	9635	0.9868	1292	0.9868	32289	0.9868	4001	0.9868
08/15	30270	0.9894	9643	0.9894	1294	0.9894	34645	0.9894	4610	0.9894
08/16	30329	0.9913	9647	0.9913	1297	0.9913	37141	0.9913	5504	0.9913
08/17	30366	0.9925	9653	0.9925	1299	0.9925	38563	0.9925	6120	0.9925
08/18	30406	0.9938	9660	0.9938	1299	0.9938	40396	0.9938	6872	0.9938
08/19	30447	0.9952	9663	0.9952	1303	0.9952	41653	0.9952	7484	0.9952
08/20	30477	0.9961	9666	0.9961	1304	0.9961	42809	0.9961	8185	0.9961
08/21	30503	0.9970	9669	0.9970	1305	0.9970	43647	0.9970	9007	0.9970
08/22	30524	0.9977	9669	0.9977	1306	0.9977	44280	0.9977	10658	0.9977
08/23	30533	0.9980	9669	0.9980	1309	0.9980	44697	0.9980	12406	0.9980
08/24	30550	0.9985	9672	0.9985	1311	0.9985	45006	0.9985	14531	0.9985
08/25	30558	0.9988	9672	0.9988	1312	0.9988	45400	0.9988	20630	0.9988
08/26	30564	0.9990	9672	0.9990	1312	0.9990	45575	0.9990	24307	0.9990
08/27	30569	0.9992	9672	0.9992	1312	0.9992	45686	0.9992	26291	0.9992
08/28	30576	0.9994	9672	0.9994	1313	0.9994	45726	0.9994	27472	0.9994
08/29	30580	0.9995	9673	0.9995	1313	0.9995	45767	0.9995	29292	0.9995
08/30	30584	0.9996	9673	0.9996	1314	0.9996	45800	0.9996	31295	0.9996
08/31	30586	0.9997	9673	0.9997	1314	0.9997	45831	0.9997	33648	0.9997
09/01	30588	0.9998	9673	0.9998	1314	0.9998	45850	0.9998	37073	0.9998
09/02	30588	0.9998	9673	0.9998	1314	0.9998	45867	0.9998	38516	0.9998
09/03	30590	0.9998	9673	0.9998	1315	0.9998	45884	0.9998	39397	0.9998
09/04	30592	0.9999	9674	0.9999	1315	0.9999	45896	0.9999	40499	0.9999
09/05	30592	0.9999	9674	0.9999	1315	0.9999	45910	0.9999	43153	0.9999
09/06	30592	0.9999	9674	0.9999	1315	0.9999	45922	0.9999	43934	0.9999
09/07	30594	1.0000	9674	1.0000	1315	1.0000	45939	1.0000	44265	1.0000
09/08	30594	1.0000	9674	1.0000	1315	1.0000	45946	1.0000	44622	1.0000
09/09	30595	1.0000	9674	1.0000	1315	1.0000	45949	1.0000	44904	1.0000
09/10	30595	1.0000	9675	1.0000	1315	1.0000	45950	1.0000	45032	1.0000
09/11	30595	1.0000	9675	1.0000	1316	1.0000	45951	1.0000	45192	1.0000
09/12	30595	1.0000	9675	1.0000	1316	1.0000	45952	1.0000	45605	1.0000

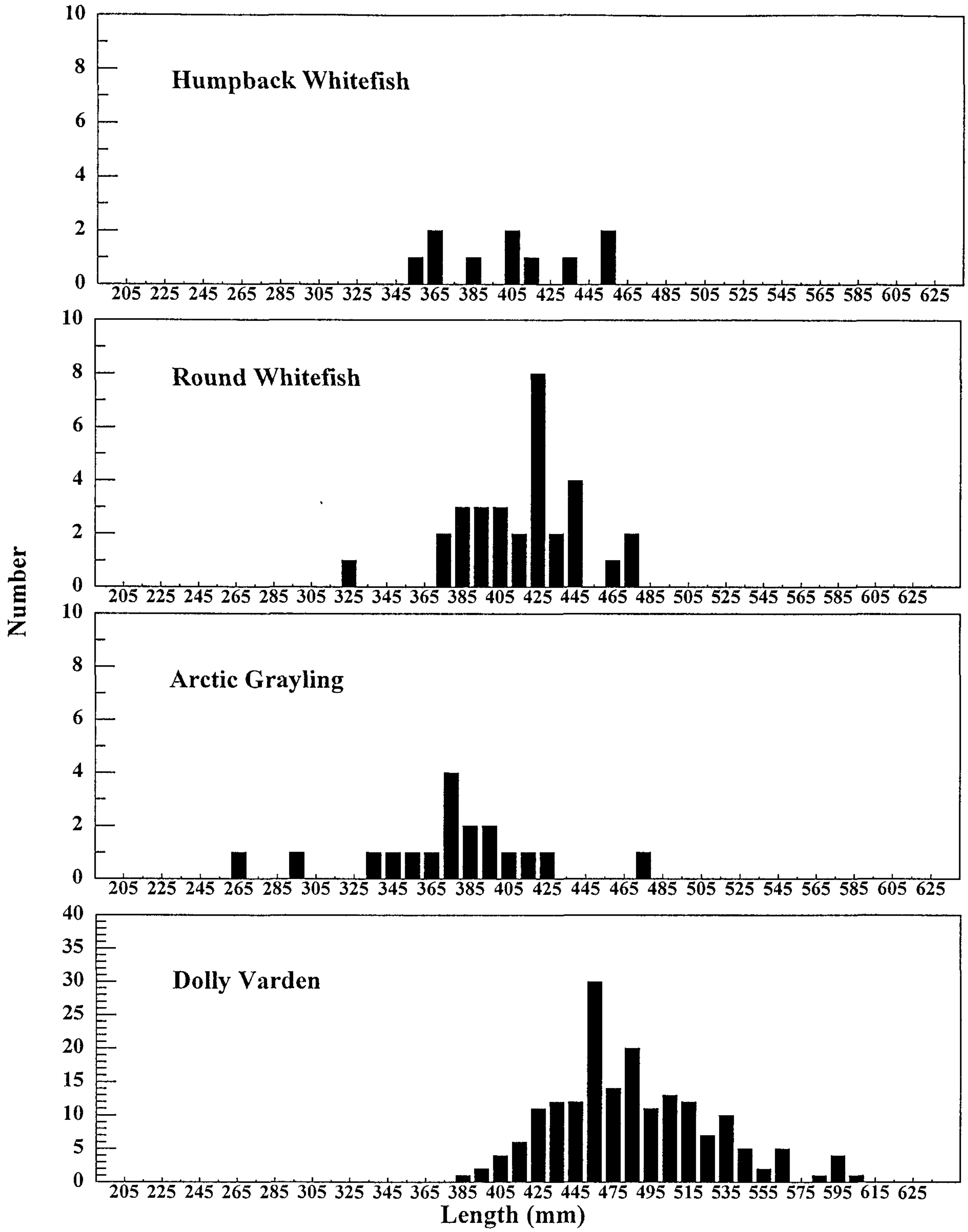
Appendix 5.-Daily weir counts and cumulative proportions of chum, chinook, sockeye, pink, and coho salmon carcasses passed downstream, Kwethluk River weir, 1992.

	Chum Salmon		Chinook Salmon Carcasses		Sockeye Salmon Carcasses		Pink Salmon Carcasses		Coho Salmon Carcasses	
	Cumulative		Cumulative		Cumulative		Cumulative		Cumulative	
Date	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion
06/20	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/21	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/22	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/23	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/24	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/25	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/26	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/27	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/28	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/29	0	0.0000	0	0.0000	0	0.0000	0	0.0000	0	0.0000
06/30	2	0.0002	0	0.0002	0	0.0002	0	0.0002	0	0.0002
07/01	3	0.0004	0	0.0004	0	0.0004	0	0.0004	0	0.0004
07/02	5	0.0006	0	0.0006	0	0.0006	0	0.0006	0	0.0006
07/03	6	0.0007	0	0.0007	0	0.0007	0	0.0007	0	0.0007
07/04	8	0.0010	0	0.0010	1	0.0010	0	0.0010	0	0.0010
07/05	11	0.0013	0	0.0013	2	0.0013	0	0.0013	0	0.0013
07/06	14	0.0017	0	0.0017	2	0.0017	0	0.0017	0	0.0017
07/07	26	0.0032	0	0.0032	2	0.0032	0	0.0032	0	0.0032
07/08	47	0.0057	0	0.0057	3	0.0057	0	0.0057	0	0.0057
07/09	83	0.0101	0	0.0101	4	0.0101	0	0.0101	0	0.0101
07/10	132	0.0161	1	0.0161	5	0.0161	0	0.0161	0	0.0161
07/11	179	0.0218	2	0.0218	5	0.0218	0	0.0218	0	0.0218
07/12	251	0.0306	2	0.0306	7	0.0306	0	0.0306	0	0.0306
07/13	354	0.0431	2	0.0431	9	0.0431	0	0.0431	0	0.0431
07/14	445	0.0542	3	0.0542	9	0.0542	0	0.0542	0	0.0542
07/15	532	0.0648	4	0.0648	14	0.0648	0	0.0648	0	0.0648
07/16	608	0.0741	4	0.0741	15	0.0741	1	0.0741	0	0.0741
07/17	726	0.0885	6	0.0885	18	0.0885	1	0.0885	0	0.0885
07/18	886	0.1079	6	0.1079	22	0.1079	2	0.1079	0	0.1079
07/19	1038	0.1265	14	0.1265	22	0.1265	4	0.1265	0	0.1265
07/20	1201	0.1463	16	0.1463	30	0.1463	5	0.1463	0	0.1463
07/21	1363	0.1661	21	0.1661	30	0.1661	6	0.1661	0	0.1661
07/22	1504	0.1832	30	0.1832	33	0.1832	6	0.1832	0	0.1832
07/23	1641	0.1999	37	0.1999	36	0.1999	8	0.1999	0	0.1999
07/24	1825	0.2223	46	0.2223	36	0.2223	9	0.2223	0	0.2223
07/25	2106	0.2566	56	0.2566	37	0.2566	10	0.2566	0	0.2566
07/26	2400	0.2924	80	0.2924	39	0.2924	19	0.2924	0	0.2924
07/27	2682	0.3268	100	0.3268	45	0.3268	28	0.3268	0	0.3268
07/28	2966	0.3614	122	0.3614	47	0.3614	39	0.3614	0	0.3614
07/29	3252	0.3962	170	0.3962	47	0.3962	61	0.3962	0	0.3962
07/30	3507	0.4273	198	0.4273	47	0.4273	87	0.4273	0	0.4273
07/31	3776	0.4600	239	0.4600	48	0.4600	119	0.4600	0	0.4600

-CONTINUED-

Appendix 5.-(continued)

	Chum Salmon		Chinook Salmon		Sockeye Salmon		Pink Salmon		Coho Salmon	
	Cumulative		Cumulative		Cumulative		Cumulative		Cumulative	
Date	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion	Carcasses	Proportion
08/01	5191	0.6324	488	0.6324	55	0.6324	650	0.6324	1	0.6324
08/02	5332	0.6496	522	0.6496	55	0.6496	693	0.6496	1	0.6496
08/03	5582	0.6801	568	0.6801	55	0.6801	757	0.6801	2	0.6801
08/04	5866	0.7147	624	0.7147	56	0.7147	853	0.7147	2	0.7147
08/05	6193	0.7545	693	0.7545	56	0.7545	946	0.7545	3	0.7545
08/06	6386	0.7780	748	0.7780	57	0.7780	1030	0.7780	3	0.7780
08/07	6570	0.8004	799	0.8004	58	0.8004	1122	0.8004	4	0.8004
08/08	6762	0.8238	858	0.8238	59	0.8238	1236	0.8238	5	0.8238
08/09	6906	0.8414	892	0.8414	59	0.8414	1361	0.8414	5	0.8414
08/10	7015	0.8547	935	0.8547	60	0.8547	1528	0.8547	5	0.8547
08/11	7215	0.8790	969	0.8790	62	0.8790	1721	0.8790	6	0.8790
08/12	7365	0.8973	1027	0.8973	67	0.8973	1969	0.8973	6	0.8973
08/13	7526	0.9169	1052	0.9169	68	0.9169	2253	0.9169	7	0.9169
08/14	7640	0.9308	1073	0.9308	73	0.9308	2615	0.9308	8	0.9308
08/15	7710	0.9393	1100	0.9393	74	0.9393	3013	0.9393	8	0.9393
08/16	7793	0.9494	1115	0.9494	75	0.9494	3566	0.9494	9	0.9494
08/17	7863	0.9580	1133	0.9580	76	0.9580	4190	0.9580	10	0.9580
08/18	7922	0.9652	1139	0.9652	77	0.9652	4977	0.9652	11	0.9652
08/19	7972	0.9712	1145	0.9712	80	0.9712	5923	0.9712	11	0.9712
08/20	8016	0.9766	1155	0.9766	83	0.9766	6798	0.9766	11	0.9766
08/21	8035	0.9789	1157	0.9789	84	0.9789	7727	0.9789	11	0.9789
08/22	8075	0.9838	1164	0.9838	88	0.9838	8612	0.9838	14	0.9838
08/23	8092	0.9859	1166	0.9859	91	0.9859	9631	0.9859	15	0.9859
08/24	8120	0.9893	1167	0.9893	94	0.9893	10533	0.9893	17	0.9893
08/25	8141	0.9918	1168	0.9918	96	0.9918	11343	0.9918	19	0.9918
08/26	8153	0.9933	1169	0.9933	97	0.9933	12050	0.9933	21	0.9933
08/27	8159	0.9940	1169	0.9940	100	0.9940	12647	0.9940	25	0.9940
08/28	8171	0.9955	1169	0.9955	106	0.9955	13315	0.9955	25	0.9955
08/29	8183	0.9970	1169	0.9970	111	0.9970	13668	0.9970	25	0.9970
08/30	8191	0.9979	1169	0.9979	114	0.9979	14029	0.9979	28	0.9979
08/31	8197	0.9987	1169	0.9987	117	0.9987	14261	0.9987	32	0.9987
09/01	8200	0.9990	1169	0.9990	117	0.9990	14383	0.9990	32	0.9990
09/02	8202	0.9993	1169	0.9993	118	0.9993	14451	0.9993	32	0.9993
09/03	8207	0.9999	1169	0.9999	121	0.9999	14508	0.9999	32	0.9999
09/04	8207	0.9999	1169	0.9999	121	0.9999	14568	0.9999	32	0.9999
09/05	8207	0.9999	1169	0.9999	121	0.9999	14591	0.9999	32	0.9999
09/06	8208	1.0000	1169	1.0000	122	1.0000	14622	1.0000	32	1.0000
09/07	8208	1.0000	1169	1.0000	122	1.0000	14637	1.0000	32	1.0000
09/08	8208	1.0000	1169	1.0000	122	1.0000	14650	1.0000	33	1.0000
09/09	8208	1.0000	1169	1.0000	122	1.0000	14658	1.0000	34	1.0000
09/10	8208	1.0000	1169	1.0000	122	1.0000	14665	1.0000	40	1.0000
09/11	8208	1.0000	1169	1.0000	122	1.0000	14674	1.0000	42	1.0000
09/12	8208	1.0000	1169	1.0000	122	1.0000	14674	1.0000	42	1.0000



APPENDIX 6.–Length frequency in 10 mm increments for humpback whitefish, round whitefish, Arctic grayling and Arctic char sampled at the Kwethluk River weir, 1992.

Appendix 7 -Estimated age and sex composition of weekly chum salmon passage and estimated design effects (Rao and Thomas 1989) from the Kwethluk River, 1992.

		Brood Year and Age Group				
		1989	1988	1987	1986	
		0.2	0.3	0.4	0.5	Total
Stratum 1: 06/21 - 06/27						
Sampling Dates: 6/24,25						
Female:	Number in Sample:	0	7	36	3	46
	Estimated % of Escapement:	0 0	4 4	22 5	1 9	28 8
	Estimated Escapement:	0	59	303	25	387
	Standard Error:	0 0	20 5	41 9	13 6	
Male:	Number in Sample:	0	21	83	10	114
	Estimated % of Escapement:	0 0	13 1	51 9	6 3	71 3
	Estimated Escapement:	0	177	699	84	960
	Standard Error:	0 0	33 9	50 1	24 3	
Total:	Number in Sample:	0	28	119	13	160
	Estimated % of Escapement:	0 0	17 5	74 4	8 1	100 0
	Estimated Escapement:	0	236	1,002	109	1,347
	Standard Error:	0 0	38 1	43 8	27 4	
Stratum 2: 06/28 - 07/04						
Sampling Dates: 6/28						
Female:	Number in Sample:	0	15	49	2	66
	Estimated % of Escapement:	0 0	9 4	30 6	1 3	41 3
	Estimated Escapement:	0	284	928	38	1,250
	Standard Error:	0 0	68 2	107 8	26 0	
Male:	Number in Sample:	0	29	63	2	94
	Estimated % of Escapement:	0 0	18 1	39 4	1 3	58 8
	Estimated Escapement:	0	549	1,193	38	1,780
	Standard Error:	0 0	90 1	114 3	26 0	
Total:	Number in Sample:	0	44	112	4	160
	Estimated % of Escapement:	0 0	27 5	70 0	2 5	100 0
	Estimated Escapement:	0	833	2,121	76	3,030
	Standard Error:	0 0	104 4	107 2	36 5	
Stratum 3: 07/05 - 07/11						
Sampling Dates: 7/5						
Female:	Number in Sample:	0	39	45	3	87
	Estimated % of Escapement:	0 0	24 4	28 1	1 9	54 4
	Estimated Escapement:	0	1,378	1,590	106	3,075
	Standard Error:	0 0	189 8	198 8	60 0	
Male:	Number in Sample:	0	29	39	5	73
	Estimated % of Escapement:	0 0	18 1	24 4	3 1	45 6
	Estimated Escapement:	0	1,025	1,378	177	2,580
	Standard Error:	0 0	170 3	189 8	76 9	
Total:	Number in Sample:	0	68	84	8	160
	Estimated % of Escapement:	0 0	42 5	52 5	5 0	100 0
	Estimated Escapement:	0	2,403	2,969	283	5,655
	Standard Error:	0 0	218 5	220 8	96 3	
Stratum 4: 07/12 - 07/18						
Sampling Dates: 7/13						
Female:	Number in Sample:	3	64	25	2	94
	Estimated % of Escapement:	1 9	40 0	15 6	1 3	58 8
	Estimated Escapement:	109	2,328	910	73	3,420
	Standard Error:	61 8	223 0	165 3	50 6	
Male:	Number in Sample:	0	41	21	4	66
	Estimated % of Escapement:	0 0	25 6	13 1	2 5	41 3
	Estimated Escapement:	0	1,492	764	146	2,401
	Standard Error:	0 0	198 7	153 7	71 1	
Total:	Number in Sample:	3	105	46	6	160
	Estimated % of Escapement:	1 9	65 6	28 8	3 8	100 0
	Estimated Escapement:	109	3,820	1,674	218	5,821
	Standard Error:	61 8	216 2	206 0	86 5	

-CONTINUED

Appendix 7.-(continued)

		Brood Year and Age Group				
		1989	1988	1987	1986	
		0.2	0.3	0.4	0.5	Total
Stratum 5: 07/19 - 07/25						
Sampling Dates: 7/19						
Female:	Number in Sample:	5	66	25	0	96
	Estimated % of Escapement:	3 1	41 3	15 6	0 0	60 0
	Estimated Escapement:	177	2,336	885	0	3,398
	Standard Error:	77 0	218 0	160 8	0 0	
Male:	Number in Sample:	0	47	17	0	64
	Estimated % of Escapement:	0 0	29 4	10 6	0 0	40 0
	Estimated Escapement:	0	1,664	602	0	2,266
	Standard Error:	0 0	201 7	136 5	0 0	
Total:	Number in Sample:	5	113	42	0	160
	Estimated % of Escapement:	3 1	70 6	26 3	0 0	100 0
	Estimated Escapement:	177	4,000	1,487	0	5,664
	Standard Error:	77 0	201 7	194 8	0 0	
Stratum 6: 07/26 - 08/01						
Sampling Dates: 7/27						
Female:	Number in Sample:	4	78	17	0	99
	Estimated % of Escapement:	2 5	48 8	10 6	0 0	61 9
	Estimated Escapement:	122	2,374	517	0	3,013
	Standard Error:	59 3	189 8	117 0	0 0	
Male:	Number in Sample:	1	48	12	0	61
	Estimated % of Escapement:	0 6	30 0	7 5	0 0	38 1
	Estimated Escapement:	30	1,461	365	0	1,856
	Standard Error:	29 9	174 0	100 0	0 0	
Total:	Number in Sample:	5	126	29	0	160
	Estimated % of Escapement:	3 1	78 8	18 1	0 0	100 0
	Estimated Escapement:	152	3,834	883	0	4,869
	Standard Error:	66 1	155 3	146 3	0 0	
Stratum 7: 08/02 - 08/08						
Sampling Dates: 8/3,4						
Female:	Number in Sample:	7	93	10	0	110
	Estimated % of Escapement:	4 4	58 1	6 3	0 0	68 8
	Estimated Escapement:	120	1,600	172	0	1,893
	Standard Error:	43 3	104 5	51 3	0 0	
Male:	Number in Sample:	1	42	7	0	50
	Estimated % of Escapement:	0 6	26 3	4 4	0 0	31 3
	Estimated Escapement:	17	723	120	0	860
	Standard Error:	16 7	93 2	43 3	0 0	
Total:	Number in Sample:	8	135	17	0	160
	Estimated % of Escapement:	5 0	84 4	10 6	0 0	100 0
	Estimated Escapement:	138	2,323	293	0	2,753
	Standard Error:	46 2	76 9	65 3	0 0	
Stratum 8: 08/09 - 08/15						
Sampling Dates: 8/10,11,14,15						
Female:	Number in Sample:	2	63	6	1	72
	Estimated % of Escapement:	2 1	67 0	6 4	1 1	76 6
	Estimated Escapement:	24	757	72	12	866
	Standard Error:	16 2	52 7	27 4	11 5	
Male:	Number in Sample:	0	17	5	0	22
	Estimated % of Escapement:	0 0	18 1	5 3	0 0	23 4
	Estimated Escapement:	0	204	60	0	264
	Standard Error:	0 0	43 2	25 2	0 0	
Total:	Number in Sample:	2	80	11	1	94
	Estimated % of Escapement:	2 1	85 1	11 7	1 1	100 0
	Estimated Escapement:	24	962	132	12	1,130
	Standard Error:	16 2	39 9	36 1	11 5	

-CONTINUED-

Appendix 7.-(continued)

		Brood Year and Age Group				
		1989	1988	1987	1986	
		0.2	0.3	0.4	0.5	Total
Stratum 9: 08/16 - 08/22						
Sampling Dates: 8/16,17,20						
Female:	Number in Sample:	1	36	3	0	40
	Estimated % of Escapement:	1 9	67 9	5 7	0 0	75 5
	Estimated Escapement:	6	221	18	0	246
	Standard Error:	5 6	19 3	9 6	0 0	
Male:	Number in Sample:	0	12	1	0	13
	Estimated % of Escapement:	0 0	22 6	1 9	0 0	24 5
	Estimated Escapement:	0	74	6	0	80
	Standard Error:	0 0	17 3	5 6	0 0	
Total:	Number in Sample:	1	48	4	0	53
	Estimated % of Escapement:	1 9	90 6	7 5	0 0	100 0
	Estimated Escapement:	6	295	25	0	326
	Standard Error:	5 6	12 1	10 9	0 0	
Strata 1 - 9: 06/21 - 08/22						
Sampling Dates: 6/24 - 8/20						
Female:	Number in Sample:	22	461	216	11	710
	% Females in Age Group:	3 2	64 6	30 8	1 4	100 0
	Estimated % of Escapement:	1 8	37 1	17 6	0 8	57 4
	Estimated Escapement:	559	11,339	5,396	254	17,547
	Standard Error:	124 2	434 1	351 0	84 5	
	Estimated Design Effects:	1 206	1 130	1 187	1 216	1 186
Male:	Number in Sample:	2	286	248	21	557
	% Males in Age Group:	0 4	56 5	39 8	3 4	100 0
	Estimated % of Escapement:	0 2	24 1	17 0	1 5	42 6
	Estimated Escapement:	48	7,368	5,188	444	13,048
	Standard Error:	34 3	399 5	326 2	110 6	
	Estimated Design Effects:	1 063	1 222	1 059	1 197	1 186
Total:	Number in Sample:	24	747	464	32	1,267
	Estimated % of Escapement:	2 0	61 1	34 6	2 3	100 0
	Estimated Escapement:	606	18,707	10,584	698	30,595
	Standard Error:	128 6	423 5	411 9	137 8	
	Estimated Design Effects:	1 1931	1 055	1 048	1 192	

Appendix 8 - Estimated age and sex composition of weekly chinook salmon passage and estimated design effects (Rao and Thomas 1989) from the Kwethluk River, 1992.

		Brood Year and Age Group								
		1989	1988	1987	1987	1986	1986	1985	1985	
		1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Stratum 1: 06/21 - 06/27										
Sampling Dates: 6/25,26,27										
Female:	Number in Sample:	0	11	10	0	3	0	0	0	24
	Estimated % of Escapement:	0 0	17 5	15 9	0 0	4 8	0 0	0 0	0 0	38 1
	Estimated Escapement:	0	26	24	0	7	0	0	0	57
	Standard Error:	0 0	5 5	5 3	0 0	3 1	0 0	0 0	0 0	
Male:	Number in Sample:	6	14	12	0	7	0	0	0	39
	Estimated % of Escapement:	9 5	22 2	19 0	0 0	11 1	0 0	0 0	0 0	61 9
	Estimated Escapement:	14	33	28	0	17	0	0	0	92
	Standard Error:	4 2	6 0	5 6	0 0	4 5	0 0	0 0	0 0	
Total:	Number in Sample:	6	25	22	0	10	0	0	0	63
	Estimated % of Escapement:	9 5	39 7	34 9	0 0	15 9	0 0	0 0	0 0	100 0
	Estimated Escapement:	14	59	52	0	24	0	0	0	149
	Standard Error:	4 2	7 0	6 9	0 0	5 3	0 0	0 0	0 0	
Stratum 2: 06/28 - 07/04										
Sampling Dates: 6/28,29,30										
Female:	Number in Sample:	0	4	1	0	23	0	0	0	28
	Estimated % of Escapement:	0 0	3 0	0 8	0 0	17 3	0 0	0 0	0 0	21 1
	Estimated Escapement:	0	77	19	0	442	0	0	0	538
	Standard Error:	0 0	37 0	18 7	0 0	82 0	0 0	0 0	0 0	
Male:	Number in Sample:	0	47	38	0	20	0	0	0	105
	Estimated % of Escapement:	0 0	35 3	28 6	0 0	15 0	0 0	0 0	0 0	78 9
	Estimated Escapement:	0	904	731	0	385	0	0	0	2,019
	Standard Error:	0 0	103 6	97 9	0 0	77 5	0 0	0 0	0 0	
Total:	Number in Sample:	0	51	39	0	43	0	0	0	133
	Estimated % of Escapement:	0 0	38 3	29 3	0 0	32 3	0 0	0 0	0 0	100 0
	Estimated Escapement:	0	981	750	0	827	0	0	0	2,557
	Standard Error:	0 0	105 4	98 6	0 0	101 4	0 0	0 0	0 0	
Stratum 3: 07/05 - 07/11										
Sampling Dates: 7/5,6										
Female:	Number in Sample:	0	1	1	0	25	0	2	0	29
	Estimated % of Escapement:	0 0	0 7	0 7	0 0	18 5	0 0	1 5	0 0	21 5
	Estimated Escapement:	0	24	24	0	602	0	48	0	698
	Standard Error:	0 0	23 6	23 6	0 0	106 8	0 0	33 2	0 0	
Male:	Number in Sample:	10	61	28	0	7	0	0	0	106
	Estimated % of Escapement:	7 4	45 2	20 7	0 0	5 2	0 0	0 0	0 0	78 5
	Estimated Escapement:	241	1,469	674	0	169	0	0	0	2,553
	Standard Error:	72 0	136 8	111 5	0 0	61 0	0 0	0 0	0 0	
Total:	Number in Sample:	10	62	29	0	32	0	2	0	135
	Estimated % of Escapement:	7 4	45 9	21 5	0 0	23 7	0 0	1 5	0 0	100 0
	Estimated Escapement:	241	1,493	698	0	771	0	48	0	3,251
	Standard Error:	72 0	137 0	112 9	0 0	116 9	0 0	33 2	0 0	
Stratum 4: 07/12 - 07/18										
Sampling Dates: 7/13,14,15										
Female:	Number in Sample:	0	1	1	0	39	0	3	0	44
	Estimated % of Escapement:	0 0	0 8	0 8	0 0	29 8	0 0	2 3	0 0	33 6
	Estimated Escapement:	0	15	15	0	590	0	45	0	665
	Standard Error:	0 0	14 6	14 6	0 0	76 8	0 0	25 1	0 0	
Male:	Number in Sample:	7	35	33	1	11	0	0	0	87
	Estimated % of Escapement:	5 3	26 7	25 2	0 8	8 4	0 0	0 0	0 0	66 4
	Estimated Escapement:	106	529	499	15	166	0	0	0	1,316
	Standard Error:	37 8	74 3	72 9	14 6	46 6	0 0	0 0	0 0	
Total:	Number in Sample:	7	36	34	1	50	0	3	0	131
	Estimated % of Escapement:	5 3	27 5	26 0	0 8	38 2	0 0	2 3	0 0	100 0
	Estimated Escapement:	106	544	514	15	756	0	45	0	1,981
	Standard Error:	37 8	75 0	73 6	14 6	81 6	0 0	25 1	0 0	

-CONTINUED-

Appendix 8.- (continued)

		Brood Year and Age Group								
		1989	1988	1987	1987	1986	1986	1985	1985	
		1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Stratum 5: 07/19 - 07/25										
Sampling Dates: 7/19,20,21										
Female:	Number in Sample:	0	0	2	0	35	0	2	1	40
	Estimated % of Escapement:	0 0	0 0	1 6	0 0	27 8	0 0	1 6	0 8	31 7
	Estimated Escapement:	0	0	15	0	258	0	15	7	295
	Standard Error:	0 0	0 0	9 7	0 0	34 6	0 0	9 7	6 9	
Male:	Number in Sample:	13	37	21	1	12	1	1	0	86
	Estimated % of Escapement:	10 3	29 4	16 7	0 8	9 5	0 8	0 8	0 0	68 3
	Estimated Escapement:	96	273	155	7	89	7	7	0	635
	Standard Error:	23 5	35 2	28 8	6 9	22 7	6 9	6 9	0 0	
Total:	Number in Sample:	13	37	23	1	47	1	3	1	126
	Estimated % of Escapement:	10 3	29 4	18 3	0 8	37 3	0 8	2 4	0 8	100 0
	Estimated Escapement:	96	273	170	7	347	7	22	7	930
	Standard Error:	23 5	35 2	29 9	6 9	37 4	6 9	11 8	6 9	
Stratum 6: 07/26 - 08/01										
Sampling Dates: 7/27,28,29,30,31										
Female:	Number in Sample:	0	1	5	0	22	0	1	0	29
	Estimated % of Escapement:	0 0	0 8	3 8	0 0	16 8	0 0	0 8	0 0	22 1
	Estimated Escapement:	0	3	17	0	75	0	3	0	99
	Standard Error:	0 0	2 9	6 3	0 0	12 4	0 0	2 9	0 0	
Male:	Number in Sample:	34	36	19	3	7	1	0	2	102
	Estimated % of Escapement:	26 0	27 5	14 5	2 3	5 3	0 8	0 0	1 5	77 9
	Estimated Escapement:	116	123	65	10	24	3	0	7	349
	Standard Error:	14 5	14 8	11 6	4 9	7 4	2 9	0 0	4 1	
Total:	Number in Sample:	34	37	24	3	29	1	1	2	131
	Estimated % of Escapement:	26 0	28 2	18 3	2 3	22 1	0 8	0 8	1 5	100 0
	Estimated Escapement:	116	127	82	10	99	3	3	7	448
	Standard Error:	14 5	14 9	12 8	4 9	13 7	2 9	2 9	4 1	
Stratum 7: 08/02 - 08/08										
Sampling Dates: 8/3,4,5,6										
Female:	Number in Sample:	0	0	0	0	7	0	0	0	7
	Estimated % of Escapement:	0 0	0 0	0 0	0 0	24 1	0 0	0 0	0 0	24 1
	Estimated Escapement:	0	0	0	0	47	0	0	0	47
	Standard Error:	0 0	0 0	0 0	0 0	14 5	0 0	0 0	0 0	
Male:	Number in Sample:	3	12	4	1	2	0	0	0	22
	Estimated % of Escapement:	10 3	41 4	13 8	3 4	6 9	0 0	0 0	0 0	75 9
	Estimated Escapement:	20	81	27	7	13	0	0	0	148
	Standard Error:	10 4	16 7	11 7	6 2	8 6	0 0	0 0	0 0	
Total:	Number in Sample:	3	12	4	1	9	0	0	0	29
	Estimated % of Escapement:	10 3	41 4	13 8	3 4	31 0	0 0	0 0	0 0	100 0
	Estimated Escapement:	20	81	27	7	61	0	0	0	195
	Standard Error:	10 4	16 7	11 7	6 2	15 7	0 0	0 0	0 0	
Stratum 8: 08/09 - 09/12										
Sampling Dates: 8/10,11,14,15,17										
Female:	Number in Sample:	0	0	0	0	0	0	0	0	0
	Estimated % of Escapement:	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
	Estimated Escapement:	0	0	0	0	0	0	0	0	0
	Standard Error:	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	
Male:	Number in Sample:	4	5	0	0	0	0	0	0	9
	Estimated % of Escapement:	44 4	55 6	0 0	0 0	0 0	0 0	0 0	0 0	100 0
	Estimated Escapement:	73	91	0	0	0	0	0	0	164
	Standard Error:	28 0	28 0	0 0	0 0	0 0	0 0	0 0	0 0	
Total:	Number in Sample:	4	5	0	0	0	0	0	0	9
	Estimated % of Escapement:	44 4	55 6	0 0	0 0	0 0	0 0	0 0	0 0	100 0
	Estimated Escapement:	73	91	0	0	0	0	0	0	164
	Standard Error:	28 0	28 0	0 0	0 0	0 0	0 0	0 0	0 0	

-CONTINUED-

Appendix 8.- (continued)

		Brood Year and Age Group								
		1989	1988	1987	1987	1986	1986	1985	1985	
		1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Strata 1 - 8: 06/21 - 08/15										
Sampling Dates: 6/21 - 8/17										
Female:	Number in Sample:	0	18	20	0	154	0	8	1	201
	% Females in Age Group:	0 0	6 1	4 7	0 0	84 2	0 0	4 7	0 3	100 0
	Estimated % of Escapement:	0 0	1 5	1 2	0 0	20 9	0 0	1 2	0 1	24 8
	Estimated Escapement:	0	146	114	0	2,022	0	112	7	2,400
	Standard Error:	0 0	46 7	35 8	0 0	160 0	0 0	42 8	6 9	
	Estimated Design Effects:	0 000	1 263	0 965	0 000	1 327	0 000	1 377	0 577	1 315
Male:	Number in Sample:	77	247	155	6	66	2	1	2	556
	% Males in Age Group:	9 2	48 2	30 0	0 5	11 8	0 1	0 1	0 1	100 0
	Estimated % of Escapement:	6 9	36 2	22 5	0 4	8 9	0 1	0 1	0 1	75 2
	Estimated Escapement:	666	3,503	2,179	39	862	11	7	7	7,275
	Standard Error:	91 0	193 7	168 7	18 0	112 0	7 4	6 9	4 1	
	Estimated Design Effects:	1 116	1 389	1 395	0 721	1 326	0 479	0 577	0 265	1 315
Total:	Number in Sample:	77	265	175	6	220	2	9	3	757
	Estimated % of Escapement:	6 9	37 7	23 7	0 4	29 8	0 1	1 2	0 1	100 0
	Estimated Escapement:	666	3,649	2,293	39	2,884	11	119	14	9,675
	Standard Error:	91 0	195 1	170 7	18 0	180 2	7 4	43 4	8 0	
	Estimated Design Effects:	1 1162	1 386	1 379	0 721	1 330	0 479	1 328	0 428	

Appendix 9 -Estimated age and sx composition of weekly sockeye salmon passage and estimated design effects (Rao and Thomas 1989) from the Kwethluk River, 1992

		Brood Year and Age Group								
		1989	1988	1988	1987	1987	1987	1986	1986	
		0.2	1.2	0.3	1.3	0.4	2.2	1.4	2.3	Total
Stratum 1: 06/21 - 06/27										
Sampling Dates: 6/25,26 27										
Female:	Number in Sample:	0	3	3	51	0	0	3	2	62
	Estimated % of Escapement	0 0	3 4	3 4	58 0	0 0	0 0	3 4	2 3	70 5
	Estimated Escapement:	0	9	9	158	0	0	9	6	192
	Standard Error:	0 0	4 4	4 4	11 9	0 0	0 0	4 4	3 6	
Male:	Number in Sample:	0	1	0	22	0	1	1	1	26
	Estimated % of Escapement	0 0	1 1	0 0	25 0	0 0	1 1	1 1	1 1	29 5
	Estimated Escapement:	0	3	0	68	0	3	3	3	81
	Standard Error:	0 0	2 6	0 0	10 4	0 0	2 6	2 6	2 6	
Total:	Number in Sample:	0	4	3	73	0	1	4	3	88
	Estimated % of Escapement	0 0	4 5	3 4	83 0	0 0	1 1	4 5	3 4	100 0
	Estimated Escapement:	0	12	9	226	0	3	12	9	273
	Standard Error:	0 0	5 0	4 4	9 1	0 0	2 6	5 0	4 4	
Stratum 2: 06/28 - 07/04										
Sampling Dates: 6/28,29,30										
Female:	Number in Sample:	0	3	1	46	0	0	1	2	53
	Estimated % of Escapement	0 0	3 6	1 2	55 4	0 0	0 0	1 2	2 4	63 9
	Estimated Escapement:	0	13	4	196	0	0	4	9	225
	Standard Error:	0 0	6 4	3 7	16 9	0 0	0 0	3 7	5 2	
Male:	Number in Sample:	0	6	2	19	1	0	0	2	30
	Estimated % of Escapement	0 0	7 2	2 4	22 9	1 2	0 0	0 0	2 4	36 1
	Estimated Escapement:	0	26	9	81	4	0	0	9	128
	Standard Error:	0 0	8 8	5 2	14 3	3 7	0 0	0 0	5 2	
Total:	Number in Sample:	0	9	3	65	1	0	1	4	83
	Estimated % of Escapement	0 0	10 8	3 6	78 3	1 2	0 0	1 2	4 8	100 0
	Estimated Escapement:	0	38	13	276	4	0	4	17	353
	Standard Error:	0 0	10 6	6 4	14 1	3 7	0 0	3 7	7 3	
Stratum 3: 07/05 - 08/06										
Sampling Dates: 7/5,6,14,15,19,20,21,27,28,29,30,31 and 8/3,4,5,6										
Female:	Number in Sample:	1	9	8	28	1	2	3	1	53
	Estimated % of Escapement	1 0	8 9	7 9	27 7	1 0	2 0	3 0	1 0	52 5
	Estimated Escapement:	7	61	54	189	7	13	20	7	357
	Standard Error:	6 2	17 9	16 9	28 1	6 2	8 7	10 7	6 2	
Male:	Number in Sample:	1	12	2	27	1	1	2	2	48
	Estimated % of Escapement	1 0	11 9	2 0	26 7	1 0	1 0	2 0	2 0	47 5
	Estimated Escapement:	7	81	13	182	7	7	13	13	323
	Standard Error:	6 2	20 3	8 7	27 8	6 2	6 2	8 7	8 7	
Total:	Number in Sample:	2	21	10	55	2	3	5	3	101
	Estimated % of Escapement	2 0	20 8	9 9	54 5	2 0	3 0	5 0	3 0	100 0
	Estimated Escapement:	13	141	67	370	13	20	34	20	680
	Standard Error:	8 7	25 5	18 7	31 2	8 7	10 7	13 6	10 7	
Strata 1 - 3: 06/21 - 08/06										
Sampling Dates: 6/21 - 8/06										
Female:	Number in Sample:	1	15	12	125	1	2	7	5	168
	% Females in Age Group:	0 9	10 7	8 7	70 0	0 9	1 7	4 4	2 8	100 0
	Estimated % of Escapement	0 5	6 3	5 2	41 5	0 5	1 0	2 6	1 6	59 3
	Estimated Escapement:	7	83	67	542	7	13	34	21	775
	Standard Error:	6 2	19 5	17 9	34 9	6 2	8 7	12 1	8 9	
	Estimated Design Effects:	1 404	1 223	1 245	0 988	1 404	1 397	1 133	0 985	1 108
Male:	Number in Sample:	1	19	4	68	2	2	3	5	104
	% Males in Age Group:	1 3	20 6	4 1	62 3	2 1	1 9	3 1	4 7	100 0
	Estimated % of Escapement	0 5	8 4	1 7	25 3	0 8	0 8	1 3	1 9	40 7
	Estimated Escapement:	7	109	22	331	11	10	17	25	531
	Standard Error:	6 2	22 3	10 2	32 9	7 2	6 7	9 1	10 5	
	Estimated Design Effects:	1 404	1 233	1 205	1 121	1 208	1 168	1 261	1 140	1 108
Total:	Number in Sample:	2	34	16	193	3	4	10	10	272
	Estimated % of Escapement	1 0	14 7	6 8	66 9	1 4	1 8	3 9	3 6	100 0
	Estimated Escapement:	13	192	89	873	18	23	50	47	1,306
	Standard Error:	8 7	28 0	20 3	35 4	9 5	11 0	15 0	13 6	
	Estimated Design Effects:	1 3975	1 198	1 230	1 094	1 280	1 296	1 170	1 069	

Appendix 10.- Estimated age and sex composition of weekly coho salmon passage and estimated design (Rao and Thomas 1989) from the Kwethluk River, 1992

		Brood Year and Age Group			
		1989	1988	1987	
		1.1	2.1	3.1	Total
Stratum 1: 07/19 - 07/25					
Sampling Dates: 7/19,20,21					
Female:	Number in Sample:	0	3	0	3
	Estimated % of Escapement:	0.0	75.0	0.0	75.0
	Estimated Escapement:	0	21	0	21
	Standard Error:	0.0	6.5	0.0	
Male:	Number in Sample:	0	1	0	1
	Estimated % of Escapement:	0.0	25.0	0.0	25.0
	Estimated Escapement:	0	7	0	7
	Standard Error:	0.0	6.5	0.0	
Total:	Number in Sample:	0	4	0	4
	Estimated % of Escapement:	0.0	100.0	0.0	100.0
	Estimated Escapement:	0	28	0	28
	Standard Error:	0.0	0.0	0.0	
Stratum 2: 07/26 - 08/01					
Sampling Dates: 7/27,28,29,30,31					
Female:	Number in Sample:	1	18	2	21
	Estimated % of Escapement:	1.9	34.6	3.8	40.4
	Estimated Escapement:	4	70	8	81
	Standard Error:	3.3	11.5	4.7	
Male:	Number in Sample:	4	24	3	31
	Estimated % of Escapement:	7.7	46.2	5.8	59.6
	Estimated Escapement:	15	93	12	120
	Standard Error:	6.5	12.1	5.7	
Total:	Number in Sample:	5	42	5	52
	Estimated % of Escapement:	9.6	80.8	9.6	100.0
	Estimated Escapement:	19	162	19	201
	Standard Error:	7.1	9.6	7.1	
Stratum 3: 08/02 - 08/08					
Sampling Dates: 8/3,4 5,6					
Female:	Number in Sample:	9	38	3	50
	Estimated % of Escapement:	7.4	31.4	2.5	41.3
	Estimated Escapement:	74	314	25	413
	Standard Error:	22.4	39.7	13.3	
Male:	Number in Sample:	14	55	2	71
	Estimated % of Escapement:	11.6	45.5	1.7	58.7
	Estimated Escapement:	116	454	17	586
	Standard Error:	27.3	42.6	10.9	
Total:	Number in Sample:	23	93	5	121
	Estimated % of Escapement:	19.0	76.9	4.1	100.0
	Estimated Escapement:	190	768	41	999
	Standard Error:	33.5	36.1	17.0	
Stratum 4: 08/09 - 08/15					
Sampling Dates: 8/10,11					
Female:	Number in Sample:	10	43	6	59
	Estimated % of Escapement:	7.5	32.3	4.5	44.4
	Estimated Escapement:	254	1,093	153	1,500
	Standard Error:	76.1	135.0	59.9	
Male:	Number in Sample:	9	64	1	74
	Estimated % of Escapement:	6.8	48.1	0.8	55.6
	Estimated Escapement:	229	1,627	25	1,882
	Standard Error:	72.5	144.2	24.9	
Total:	Number in Sample:	19	107	7	133
	Estimated % of Escapement:	14.3	80.5	5.3	100.0
	Estimated Escapement:	483	2,721	178	3,382
	Standard Error:	101.0	114.4	64.4	

-CONTINUED-

Appendix 10 - (continued)

		Brood Year and Age Group			
		1989	1988	1987	
		1.1	2.1	3.1	Total
Stratum 5: 08/16 - 08/22					
Sampling Dates: 8/16,17,18					
Female:	Number in Sample:	6	41	3	50
	Estimated % of Escapement:	4 8	32 5	2 4	39 7
	Estimated Escapement:	288	1 968	144	2,400
	Standard Error:	114 0	250 8	81 6	
Male:	Number in Sample:	11	64	1	76
	Estimated % of Escapement:	8 7	50 8	0 8	60 3
	Estimated Escapement:	528	3,072	48	3,648
	Standard Error:	151 1	267 6	47 5	
Total:	Number in Sample:	17	105	4	126
	Estimated % of Escapement:	13 5	83 3	3 2	100 0
	Estimated Escapement:	816	5,040	192	6,048
	Standard Error:	182 9	199 5	93 8	
Stratum 6: 08/23 - 08/29					
Sampling Dates: 8/24,25					
Female:	Number in Sample:	4	50	1	55
	Estimated % of Escapement:	3 2	40 0	0 8	44 0
	Estimated Escapement:	596	7,454	149	8,199
	Standard Error:	293 5	817 0	148 6	
Male:	Number in Sample:	11	58	1	70
	Estimated % of Escapement:	8 8	46 4	0 8	56 0
	Estimated Escapement:	1,640	8,646	149	10,435
	Standard Error:	472 5	831 7	148 6	
Total:	Number in Sample:	15	108	2	125
	Estimated % of Escapement:	12 0	86 4	1 6	100 0
	Estimated Escapement:	2,236	16,100	298	18,634
	Standard Error:	542 0	571 7	209 3	
Stratum 7: 08/30 - 09/05					
Sampling Dates: 8/31					
Female:	Number in Sample:	4	26	1	31
	Estimated % of Escapement:	5 3	34 2	1 3	40 8
	Estimated Escapement:	730	4,742	182	5,654
	Standard Error:	356 4	757 2	181 9	
Male:	Number in Sample:	8	35	2	45
	Estimated % of Escapement:	10 5	46 1	2 6	59 2
	Estimated Escapement:	1,459	6,383	365	8,207
	Standard Error:	489 8	795 6	255 5	
Total:	Number in Sample:	12	61	3	76
	Estimated % of Escapement:	15 8	80 3	3 9	100 0
	Estimated Escapement:	2,189	11,125	547	13,861
	Standard Error:	582 0	635 3	310 8	
Stratum 8: 09/06 - 09/12					
Sampling Dates: 9/10,11					
Female:	Number in Sample:	3	36	5	44
	Estimated % of Escapement:	3 1	37 1	5 2	45 4
	Estimated Escapement:	76	910	126	1,112
	Standard Error:	42 5	118 5	54 2	
Male:	Number in Sample:	9	43	1	53
	Estimated % of Escapement:	9 3	44 3	1 0	54 6
	Estimated Escapement:	228	1,087	25	1,340
	Standard Error:	71 2	121 8	24 8	
Total:	Number in Sample:	12	79	6	97
	Estimated % of Escapement:	12 4	81 4	6 2	100 0
	Estimated Escapement:	303	1,997	152	2,452
	Standard Error:	80 8	95 3	59 1	

-CONTINUED-

Appendix 10.- (continued)

		Brood Year and Age Group			
		1989	1988	1987	
		1.1	2.1	3.1	Total
Strata 1 - 8: 07/19 - 09/12					
Sampling Dates: 7/1 - 09/11					
Female:	Number in Sample:	37	255	21	313
	% Females in Age Group:	10 4	85 5	4 1	100 0
	Estimated % of Escapement:	4 4	36 3	1 7	42 5
	Estimated Escapement:	2,022	16,571	787	19,380
	Standard Error:	484 0	1,156 6	261 8	
	Estimated Design Effects:	1 965	2 054	1 441	2 045
Male:	Number in Sample:	66	344	11	421
	% Males in Age Group:	16 1	81 5	2 4	100 0
	Estimated % of Escapement:	9 2	46 9	1 4	57 5
	Estimated Escapement:	4,214	21,370	641	26,225
	Standard Error:	705 1	1,197 5	301 7	
	Estimated Design Effects:	2 105	2 046	2 332	2 045
Total:	Number in Sample:	103	599	32	734
	Estimated % of Escapement:	13 7	83 2	3 1	100 0
	Estimated Escapement:	6,236	37,941	1,428	45,605
	Standard Error:	826 9	890 9	396 5	
	Estimated Design Effects:	2 057688017	2 017	1 843	